INCOME TAXATION AND THE DEMAND FOR MONEY

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TABLE OF CONTENTS

Chapter Page

I. INTRODUCTION 1

Introduction 1
Objectives 4
Organization 4

II. REVIEW OF LITERATURE 6

Introduction 6
The Interest Rate Issue 7
Theoretical Work 7
The Role of the Interest Rate in the Demand for Money 7
Taxation, Interest Rate and the Demand for Money 9
Empirical Work 15
Long-Term Versus Short-Term Rate of Interest . . . 17
The Issue of the Scale Variable 20
The Stability of the Money Demand Function 25
Summary 29

III. MODEL SPECIFICATION AND ECONOMETRIC ANALYSIS 31

Introduction 31
Theoretical Work 31
The Tax Rate and the Demand for Money 34
Model Specification 38
An Aggregate Demand for Money 38
Household Demand for Money 42
Business Demand for Money 44
Statement of Hypothesis 46
Income Tax and the Elasticity Estimates 48
Testing Procedures 52
Identification and Simultaneity 56

IV. EMPIRICAL RESULTS 61

Introduction 61
Alternative Specification of a Conventional Equation . 63
Empirical Estimation 71
Aggregate Demand for Money 71
Household Demand for Money 75
Business Demand for Money 81

Chapter Page

Tax Rate and the Demand for Money: Substitution and the Risk-Sharing Effect 86
Testing Hypotheses 88
Household Demand for Money 88
Business Demand for Money 95
Aggregated Demand for Money 97
Tax Rate and the Demand for Money: An Alternative Test . . 101
Identification and Simultaneity 103
Introduction 103
Exogeneity Test 104
Aggregated Demand for Money and Simultaneity 108

V. SUMMARY AND CONCLUSION 111

SELECTED BIBLIOGRAPHY 117

APPENDIX - CONSTRUCTING MARGINAL TAX RATE AND DATA SOURCES 123

LIST OF TABLES

Table		Page
I.	Empirical Estimation of Alternative Specifications 1952:2-1980:4	64
II.	Empirical Estimation of Alternative Specifications 1952:2-1972:4	66
III.	Empirical Estimation of Alternative Specifications 1973:1-1980:4	67
IV.	Results of Chow Test for the Alternative Specifications	68
V.	Computed Error Statistics	70
VI.	Estimates of the Two Versions of the Aggregated Demand for Money 1952:2-1972:4	72
VII.	Estimates of the Two Versions of the Aggregated Demand for Money 1973:1-1980:4	76
VIII.	Results of the Empirical Estimation for the Household Demand for Money 1952:2-1972:4	78
IX.	Empirical Estimates of the Household Demand for Money 1973:1-1980:4	80
X.	Empirical Estimation of the Two Versions of the Business Demand for Money 1952:2-1972:4	82
XI.	Estimates of the Two Versions of the Business Demand for Money 1973:1-1980:4	85
XII.	The Estimated B_5^* Coefficients for the Three Demand for Money Equations 1952:4-1972:4	88
XIII.	The Estimated B_5^* Coefficients for the Three Demand for Money Equations 1973:1-1980:4	89
XIV.	Comparison of the Actual and Predicted Series at the Household Demand for Money (1952:2-1973:4)	90
XV.	Error Statistics of 1966:1-1972:4 Forecasts for the Household Demand for Money	91

Table		Page
XVI.	Results of Davidson-MacKinnon Specification Test (1952:2-1972:4)	92
XVII.	Results of Pesaran and Deaton Specification Test	94
XVIII.	Comparison of Actual and Predicted Series of the Business Demand for Money Equations 1952:2-1972:4	96
XIX.	Error Statistics of 1966-1972 Forecast for Business Demand for Money	96
XX.	Results of Davidson-MacKinnon Specification Test for Business Demand for Money	97
XXI.	Results of Pesaran-Deaton Specification Test for Business Demand for Money	97
XXII.	Comparison of the Actual and Predicted Series of the Two Specifications for the Aggregated Demand for Money (Sample Period 1952:2-1972:4)	98
XXIII.	Error Statistics for 1966-1972 Forecasts for the Aggregated Demand for Money	99
XXIV.	Results of Davidson-MacKinnon Specification Test for the Aggregate Demand for Money (1952:2-1972:4)	99
XXV.	Results of Pesaran-Deaton Specification Test for the Aggregated Demand for Money (1952:2-1972:4)	100
XXVI.	Comparison of the Actual and Predicted Series for 1964:1 and 1968:1	102
XXVII.	Estimated Lag Profile for Real Demand for Money	106
XXVIII.	F-Tests on Future Coefficients in Real-Money Demand Equations	107
XXIX.	Empirical Estimation of the Aggregated Demand for Money by TSCORC Procedure 1952:2-1972:4	109
XXX.	Average Individual Marginal Tax Rates	127

CHAPTER I

INTRODUCTION

Introduction

The demand for money deals with decisions of what proportion of the stock of wealth is held in the form of money. There is considerable controversy involved in the specification of the demand for money. The first of these controversies deals with the theoretical framework in which the demand for money can be specified. To Keynes [51], the theory of demand for money is concerned with explaining which factors determine the proportion of a financial portfolio held in the form of money as opposed to bonds. Friedman [29] treats the demand for money the same way he treats the demand for any other durable good. He basically argues that money, like any other asset, yields a flow of services to the person who holds it. This approach basically utilizes the general principle of the diminishing marginal rate of substitution between goods.

Besides the differences concerning the proper theoretical framework to use, there are other disagreements; namely, is income or wealth the relevant restraint, and which measure is the relevant income or wealth variable? What is the relevant interest rate in the demand for money?

With regard to the issue of the relevant interest rate, one may argue that the issue of long-term versus short-term interest rate has not been empirically settled. While Heller [44], Laidler [58] and

Goldfeld [35] [36] found that the short-term rate was the most appropriate measure, others such as Hamburger [39] and Lee [56] concluded that long-term interest rates and yields on savings and loans shares are the most significant interest variables in the demand for money equations. In addition, Heller and Khan [45], following Friedman's [33] suggestion, argued that the question of the proper interest rate in the demand for money function should not be restricted to short-term versus long-term rates, but the entire term structure of interest rates should be used as the proper opportunity costs of money. The general conclusion seems that it is not yet possible to state confidently which particular interest rate measure provides the most stable money demand function and the final judgment must await pending additional investigation, especially on the term structure of interest rates.

This brief summary of the literature is an indication of the considerable amount of attention that has been devoted to the question of the relevant income variable and the relevant interest rate. None of the cited studies has incorporated taxation of interest in its specification of the demand for money. For instance, the opportunity cost of holding money has typically been presented by the nominal rate of interest, and the concept of net rate of interest has been largely ignored.

A possible explanation for this lack of interest may have to do with the fact that accurate and reliable statistical series on the marginal tax rate are not available. The argument based on the unavailability of the marginal tax rate series is no longer warranted since Seater [73] and Barro and Sahasakul [3] have provided procedures for estimating the corporate and individual marginal tax rate.

[3] have provided procedures for estimating the corporate and individual marginal tax rate.

On theoretical grounds, a conventional money demand equation can be derived from a portfolio approach or transactions approach to the demand for money. Tobin [81], in his celebrated "Liquidity Preference as Behavior Towards Risk," argues that an increase in the proportional tax rate, with full offset provisions, increases the holding of risky assets in a portfolio of a given size. In other words, an increase in the tax rate decreases the demand for money (at a market rate of interest). On the other hand, following Baumol's [4] inventory theoretic technique to the transaction demand for money, one can easily identify the key element in the model as the interest rate differential between bonds and money, which creates an interest cost of holding money. According to this theory, smaller money balances are associated with high interest earnings at the expense of higher transaction costs. Individuals are assumed to act so as to maximize interest earnings on interest bearing assets, net of transaction costs, by equating the competing costs at the margin. However, for an individual who acts to maximize interest earnings, the relevant marginal opportunity cost of holding money is the after-tax rate of interest. This is most obvious since the yield on money is untaxed while the yield on all other assets falls as the marginal tax rate rises. This theory, therefore, predicts a positive and direct relationship between the tax-rate and the demand for money as a result of the effect of the tax-rate on the opportunity cost of holding money.

Based on the theoretical works just presented, it can be seen that previous work on the topic has misspecified the demand for money equation. The conventional approach toward the demand for money is to make it a function of the nominal rate of interest and an income variable. This pattern is, however, appropriate only in a country without income taxes. In a country where interest receipts are taxable, the tax-variable also enters individual constraints and determines behavior. The conclusion, therefore, follows that a fundamental aspect of the topic which has not generally been observed in empirical work on the topic is the need to incorporate the tax rate into the demand for money.

Objectives

The standard procedure in demand for money investigations is to use the demand for money as a function of national income as a proxy for transaction demand and the rate of interest as a proxy for the opportunity costs of holding money. However, the purpose of this research is to investigate the theoretical and empirical implications of incorporating income taxation into the demand for money. Given the ever increasing importance of income taxation on the flow of income, one may argue that the standard formulation of the demand for money as a function of national income and the rate of interest is inappropriate. This study investigates the hypothesis that it is the net rate of interest, i.e., interest rate after tax that is relevant to households' and firms' money holding decisions.

Organization

Chapter II of this study serves two primary purposes. It presents both theoretical and empirical work previously done on the demand for money. Special emphasis is placed on the relationship between taxation and the degree of risk in an portfolio decision, and its implication on the demand for money.

Chapter III is devoted to specifying the testable specifications for household, business, and aggregated demand for money. Also found in this chapter is a more thorough analysis of the theoretical justification of each equation. Chapter III also develops the statistical and econometric framework for the study. Specifically, the statements of the hypotheses are presented. The chapter concludes with a brief discussion of the tests to be performed and a thorough discussion of the simultaneity and identification problem.

Chapter IV applies the methodology to evaluate the proposed specification of the demand for money against its conventional form. An investigation of the alternative procedures, e.g., a simultaneous approach to the demand for money, appears at the end.

Finally, Chapter V summarizes the dissertation and highlights its major findings.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The purpose of this chapter is to outline the different theoretical arguments and major empirical findings in the area of the demand for money. Specifically, the following issues are addressed in considerable detail: What is the role of the interest rate in the money demand function? What is the most relevant interest rate to the determination of the demand for money? What is the most relevant scale variable? Does the demand for money appear to be stable over the years?

The review of literature is organized as follows. The issue of interest rates is addressed first. In this section, two aspects of interest rates are reviewed: The role of interest rates in the demand for money function and the question of what is the most relevant interest rate to the determination of the demand for money. The latter is addressed on two grounds. Following the theoretical work, it is argued that the most relevant measure of opportunity cost in the demand for money is the after tax rate of interest as opposed to the nominal rate of interest, followed by its implication on the dissertation. Next, the major empirical work is described and the issue of short-term versus long-term rate of interest is addressed. The problem of the relevant scale variable and the stability of the demand for money is discussed at the end. After discussing the major work on these subjects, a summary section recaps the main points of the empirical results with regard to the above questions.

The Interest Rate Issue

Theoretical Work

The Role of the Interest Rate in the Demand for Money. The Keynesian approach to demand for money is based upon the familiar tripartite demand for money. This construction includes, first, a transactions demand--money held both by households and business firms "to bridge the interval between the receipt of income and its disbursement," [51, p. 195]; second, the precautionary-demand which sees money held to meet forthcoming monetary obligations and, third, the speculative-demand--money held by the public due to a lack of perfect foresight with respect to the future rate of interest and the uncertainty as to the future capital value of a fixed interest bearing asset.

Keynes [51], in his discussion of the speculative and precautionary motives of holding money, has assumed that the former explicitly and the latter implicitly depend upon the rate of interest. For example, in his discussion of the speculative demand he argued that those who believe that future rates of interest will be above the rates assumed by the market have a reason for keeping cash, rather than holding bonds, and vice versa. With respect to the precautionary demand for money, Keynes argued that the essence for this demand is uncertainty about the future. Since the returns on bonds is risky, the individual has some motives to hold money. This incentive to hold money will depend on the current rate of interest, since the greater is this risk, the greater is the return on bonds; which will partially compensate for their riskiness. According to Keynes [51], the strength of the precautionary motive. . .

> depend[s] on what we may term the relative cost of holding cash. If the cash can only be retained by forgoing the purchase of a profitable asset, this increases the cost and thus weakens the motive towards holding a given amount of cash [p. 136].

So it appears that for Keynes this precautionary demand for money depends on the rate of interest.

However, with respect to the transactions demand for money, Keynes argued that this motive is basically a function of the income and the normal length or the interval between its receipts and its disbursement. According to Keynes, the transactions demand for money is:

> generally irresponsive to any influence except the actual occurrence of a change in the general economic activity and the level of incomes; whereas experience indicates that the aggregate demand for money to satisfy the speculative motive usually shows a continuous response to gradual changes in the rate of interest [p. 197].

The conclusion follows that, assuming the interval between receipts and payments is constant and does not vary with the level of income, the transactions balance is a constant proportion of the money income. According to Keynes, this motive did not as a first approximation depend on the rate of interest.

However, Baumol [4] and Tobin [80] have explored the transactions demand and have demonstrated that under certain assumptions it too will depend on the rate of interest. Tobin [81] argued that a distinction should be made between the size of the transactions balances and the composition of transactions balances. He acknowledges that the size of the transactions balances in general depends on the institutional arrangements that determine the length of the interval between individual receipts and expenditures. However, the composition of transactions balances is another matter. Cash is not the only asset in which transactions balances can be held. According to the Tobin-Baumol model, people aim to maximize the return of their portfolios. The utility-maximizing individual desires to hold some transactions balances in the form of interest earnings assets if the interest earned on these assets outweighs the cost involved in investing in bonds and disinvesting, and the inconvenience of the financial transactions involved. The conclusion follows that the proportion of cash in transactions balances varies inversely with the rate of interest if one assumes that individuals are profit-maximizers.

Today, all modern theories of the demand for money consider that interest rates on alternative assets are determinants of this demand. Keynesians have been able to explain this by either the theory of the speculative demand [81] or the modern theory of transactions demand [9] [80]. Even Friedman argues that his inability to pin down the interest elasticity of the demand for money is very different from assigning a zero value to it. According to Friedman, the interest elasticity is not very high and it appears to be less important as a determinant of the demand for money than real per capita permanent income. Despite this, he argued that "I know no empirical student of the demand for money who denies that interest rates affect the real quantity of money demanded" [30, p. 142].

Taxation, Interest Rate and the Demand for Money. Closely related to the demand for money is the problem of explaining why people should hold money in their portfolio at all when they can hold interest earning assets such as bonds. Keynesians have been able to answer this question by arguing that there are two fundamental reasons: (1) the existence of time and the fact that human action takes time and (2) uncertainty as to the future capital value of a fixed interest bearing asset. The first reason refers to the costs inherent in money transactions, of which the costs of investment and disinvestment are of great importance. The second reason, however, does not refer to general uncertainty, but to the uncertainty of the future rate of interest. That is, individuals are assumed to dislike risk on their assets and since bonds are assumed to be risky, whereas money is not, they have some reason for holding money rather than bonds [4] [81]. This is, of course, the basis of Keynes's speculative motive. The speculative demand for money plays a key role in the Keynesian demand for money theory, since Keynes consistently used this element of the demand for money as a basis for his theory to establish the interest-elasticity of the demand for money. However, the speculative motive does not necessarily depend on the existence of uncertainty in order to be operative. It merely requires individuals to maximize the returns from their portfolios given their riskiness.

Following the portfolio approach, it is obvious that in every investment decision the individual weighs the return or yield against the possible loss, or risk. The point that taxation reduces the yield is well established and is entirely evident, but the equally important relationship between taxation and the degree of risk has received little attention in the empirical and theoretical approach to the demand for money.

Domar and Musgrave [21] argued that by imposing an income tax, the Treasury becomes a partner of the investor, one who shares the gains but whose share of the losses depends upon the investor's ability to offset losses.[1] If losses cannot be offset, the investor carries the entire burden of the loss. In this case, the tax reduces the return, but leaves the degree of risk unchanged, so that the compensation per unit of risk-taking is reduced.[2] Risk-taking becomes less attractive, so the investor has an incentive to take less risk (substitution effect). But the reduction in return also means a lower income and so to maintain income, the investor's demand for risky investment increases, since risky investment can be expected to have a higher yield (income effect). A shift toward a more risky asset combination may be accomplished by reducing the proportion of the investor's total assets held in cash, that is, by larger total investment. The income and substitution effects of imposing a tax in this case are operating in opposing directions and therefore theoretically the final outcome of taxation on the proportion of total assets held in cash is uncertain.

If a complete offset of losses is possible, the yield and the risk of investing in bonds is reduced by the rate of the tax, so that the compensation per unit of risk-taking remains unchanged. Consequently, the incentive to take less risk or the substitution effect of taxation disappears. The individual's income, however, will decline and to

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[1]Loss offset provision refers to favorable treatment of capital losses from unsuccessful investments. That is when capital losses exceed capital gains, the realized capital losses may be deducted from taxable income. Such deductions reduce taxable income by the entire amount of capital losses.

[2]The key to this analysis is the interpretation of the reward for risk. If the reward is measured, not in absolute amount nor in relation to the total investment but in relation to the net amount of capital at risk, then the reward for assumption of risk will be reduced relative to the net amount of capital at risk by an income tax (provided losses cannot be offset against taxable income).

restore it, he will take more risk, or by the same token he will reduce the proportion of his total assets held in cash.

This proposition can be proved following a mathematical approach to the effect of taxation on the portfolio selection decisions of expected utility maximizing investors [61] [76]. In the following approach the basic Domar-Musgrave proposition is re-examined on the basis of expected utility approach. The discussion is restricted to portfolio choices involving two assets only. The following notation is employed [61]:

x = rate of return on risky asset

r = rate of return on riskless asset, equal to zero for money

A = investor's initial wealth

a = amount invested in the risky asset

$m = A - a$ = amount held in the riskless asset

t = proportional tax rate on investment income

Y = final wealth.

Because of considerable practical interest, this dissertation assumes that there are full loss offset provisions.

It follows that final wealth in this case is given by

$$Y = A + (1 - t)\, ax \tag{1}$$

Under the expected utility hypothesis the investor chooses the value of a, which maximizes

$$E\,[U(Y)] = E\,[U(A + (1 - t)\, ax)] \quad \text{subject to } 0 \leq a \leq A \tag{2}$$

The first derivative of (2) is

$$\frac{dE\,[U(Y)]}{da} = dE \left[\frac{U(Y)}{dY} \cdot \frac{dY}{da} \right]$$

or

$$\frac{dE\,[U(Y)]}{da} = E\,[U'(Y) \cdot (1 - t)\, x]$$

$$= (1 - t)\, E\, [U'(Y)\, x] \tag{3}$$

Following the same chain-rule applied above, the second derivative of (2) is

$$\frac{d^2\, E\, [U(Y)]}{da^2} = (1 - t)^2\, E\, [U''(Y) x^2] \tag{4}$$

To maximize the investor's expected utility then requires:

$$E\, [U'(Y)\, x] = 0 \tag{5}$$

$$E\, [U''(Y) x^2] < 0 \tag{6}$$

The investor is assumed to be risk averse, that is, $U''(Y)$ is everywhere negative. This assumption implies that the second-order condition (6) is clearly satisfied for a risk-averting investor. The first-order condition (5) defines the optimal $\underline{a}$ as a function of the tax parameter $\underline{t}$ and initial wealth $\underline{A}$. Total differentiation of (5) gives the effect of changes in $\underline{t}$ on $\underline{a}$.

$$E\, [U'(Y) x] = 0$$

$$E\, [xU''(Y)\, (dA + a(1 - t)\, dx + x(1 - t)\, da - axdt) + U'(Y) dx] = 0$$

Assuming $dA = dx = 0$

$$E\, [xU''(Y)\, ((1 - t)\, xda - axdt)] = 0$$

$$E\, [x^2 U''(Y)\, ((1 - t)\, da - adt)] = 0$$

Since $E\, [x^2 U''(Y)] < 0$. Then

$$(1 - t)\, da - adt = 0$$

$$\frac{da}{dt} = \frac{a}{1-t} \tag{7}$$

The first observation on (7) is, of course, that it confirms the Domar-Musgrave conclusion, that an increased tax rate on investment income increases holdings of the risky asset. Thus holdings of cash should necessarily decline.

Tobin [81] came to the same conclusion, that an increase in proportional tax rate, with full offset, increases the holding of the risky asset in a portfolio of a given size. According to Tobin, there is a positive relationship between the proportion of the investor's wealth held in consols (A_2) and the expected return. This can be shown as follows:

$$R = A_2 (r + g)$$

where R = return on portfolio

g = capital gain or loss

r = the current yield on consol.

Since g is a random variable with an expected value of zero, the expected return on the portfolio is:

$$E(R) = A_2 r \tag{8}$$

On the other hand, the risk attached to the portfolio is to be measured by the standard deviation of R, or:

$$\sigma_R = A_2 \sigma_g, \quad \text{since } \sigma_r = 0 \tag{9}$$

Substituting (9) into (8) gives:

$$E(R) = \frac{r}{\sigma_g} \cdot \sigma_R \tag{10}$$

Now (10) represents the locus of opportunity for risk and expected return which pictures the fact that the investor can expect more return if he assumes more risk. In this framework the result of a tax of _t_ levied on interest income and capital gains, with complete loss offset provision, would be to reduce the expected return per dollar of consols from _r_ to _r(1 - t)_ and to reduce the risk to the investor per dollar of consols from $\underline{\sigma_g}$ to $\underline{(1 - t)\sigma_g}$. The opportunity locus according to Tobin remains constant at $r(1-t)\sigma R/(1-t)\sigma_g = r\sigma R/\sigma_g$, but the imposition of taxation causes the risk consol line (9) to rotate further to the left.

So it follows that a tax of this kind reduces the demand for money at any market rate of interest.[3]

One shortcoming of this theory is seen when considering the case in which the investor divides his wealth between one riskless asset (money) and more than one risky asset. Feldstein [26] argued that the conclusion derived from this theory depends, critically, on the assumption that the portfolio contains only one risky asset. However, Richter [71] showed that with two risky assets and a quadratic utility function, the introduction of a proportional tax with full loss offset would increase the pretax portfolio variance. Therefore, Hall [38] extended Richter's result to any case in which the investor's preference could be described in terms of the mean and variance of the portfolio yield.

The conclusion follows that, although the conventional approach toward the demand for money is to make it a function of the nominal rate of interest and a scale variable, this pattern is appropriate only in the absence of income taxes. The imposition of income taxes alters the efficient asset combination through its effect on risk and yield of risky investment. The conclusion, therefore, follows that a fundamental aspect of the topic, which has not generally been observed in empirical work on the topic, is the need to incorporate the tax rate into the demand for money.

Empirical Work. While income taxation had long ago been integrated into the analysis of most areas of economic behavior, the literature lacks direct empirical analysis of the response of the demand for money

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[3]This holds if there is a single $\underline{t}$ against income and capital gains. If there is a different capital gains rate, then the result is indeterminant.

to the tax rate. However, in order to show the empirical justification of incorporating the tax rate in the demand for the money, this study resorted to another approach, namely the empirical results of the effects of taxation on portfolio choice.

In a 1949 survey, Butters [11] asked a nonrandom sample of 746 active investors how they had responded to the rise in tax rates imposed in the 1940's. Sixty-nine percent indicated that it had no influence on their investment behavior, while twenty-two percent indicated that the higher tax rates induced them to hold a more conservative portfolio.

A survey conducted by the University of Michigan Survey Research Center [2] also concluded that a large fraction of investors were not influenced by tax considerations. They concluded that only a small minority of high-income people were aware of preferential tax treatment and, in fact, took advantage of it.

Feldstein [26], in a comprehensive econometric paper, investigated the effects of taxes on household portfolio composition. He assumed that the composition of each household's portfolio depends on wealth and the perceived probability distribution of net asset yields. The age and sex of the head of the household and the ratio of human capital to total wealth were also taken into consideration. He primarily focused on the impact of the tax system through its effects on relative yield while the effects on risk were not explicitly addressed. His results indicated that: (1) the personal income tax has a very powerful effect on individuals' demand for portfolio assets, (2) higher income individuals are encouraged to hold a larger share of their portfolios in common stock and (3) the means of the pretax yield on individuals' portfolios are an increasing function of the individuals' tax rates.

Long-Term Versus Short-Term Rate of Interest. All modern theories of the demand for money consider that interest rates on alternative assets are determinants of this demand. There is also an overwhelming body of evidence in favor of inclusion of some rate of interest in the demand for money, e.g., [49] [10] [53] [55]. However, with regard to the issue of the relevant interest rate, one may argue that the issue of long-term versus short-term interest rate has not been empirically settled. One attempt to clarify this issue was made by Heller [44]. Heller compared the explanatory power of the long-term rate of interest with that of a short-term rate. Using quarterly observations for the period 1947-1958, he specified both M1 and M2 as dependent variables and concluded that the short-term rate was far superior than the long-term rate in explaining movements in the demand for money's both cases.

Heller's conclusion was confirmed by Laidler [55]. Using annual data for the time period 1892-1960, he specified an equation in log-linear form and used permanent income as the scale variable. His results indicated that, when M2 was used as the dependent variable, the short-term rate was found to be superior; while with money defined as M1, there was no doubt of the superior explanatory power of the long-term rate. However, he concluded that a short-term rate is the relevant rate and "the contradictory results obtained with the M1 definition of money reflect the fact that that definition is an unsatisfactory one" [p. 553]. The basis of his conclusion was his previous work [53] on which his results strongly supported the broad definition of money (M2) on the grounds of the stability of the money demand function.

This conclusion was confirmed by Friedman and Schwartz [31] and Goldfeld [35] [36]. Friedman and Schwartz specified a semi-log equation in which they included the absolute rather than logarithms of the rate of interest in equation. Working with the annual data they concluded that "The short-term interest rate is preferable to the long, and there is no justification for including both" [p. 267].

Goldfeld [35] experimented with five different rates of interest in his study. The rates considered were: the rate on commercial paper (RCP); the rate on time deposits (RTD); the Treasury bill rate (RTB); a weighted average saving rate (RAVG); and the corporate bond rate (RCB). His result indicated that a saving deposit rate of any sort increases the speed of adjustment from much less than 10 percent per quarter to 20 percent. The corporate bond rate (a long-term rate) never achieved statistical significance and in some equations actually reported a positive coefficient. On balance, he argued RTD and RCP worked about as well as any other. In his 1976 study, Goldfeld [36] tested several other alternatives. However, he concluded that, "It is hard to foresee much payoff from trying various interest rates" [p. 700]. Simulation performance of equations using alternatively the commercial paper rate and the Treasury bill were identical. The same was true for several different alternatives for time and saving deposits rates. The corporate bond rate, as a proxy for longer-term rates, was found to be inferior to either of the short-term market rates. The conclusion follows as the short-term market rates were found to be superior to the longer-term rates.

In an attempt to introduce an alternative to Goldfeld's equation, Hamburger [41] specified the demand for real M1 as a function of real income, lagged M1, and three rates of interest, namely, the commercial bank saving deposit rate, U.S. government bond rate and the dividend price ratio on equities. His equation performed reasonably better than Goldfeld's equation over the 1973-1977 time span.

Despite the reasonable performance of Hamburger's equation, his work was criticized on two counts. Hafer and Hein [37] were able to show that Hamburger's imposed restriction on the long-run real income elasticity equal to unity was not supported by the data, and in addition, when the commercial paper rate was added to the equation it was statistically significant and this lowered the significance of the government bond. Finally, when Hamburger's equation was adjusted for both of these shortcomings, they concluded that its root mean-squared error for dynamic forecasts exceeded that of the Goldfeld equation.

The asserted superiority of the short-term rates was challenged by Hamburger [39] and Lee [56]. Hamburger, concentrating on the household demand for money, concluded that long-term interest rates were the relevant determinants of its demand for cash balances. The basic argument put forth by Hamburger was, in the household demand for money, one should include two yields, one on debts and one on equities.

Heller and Khan [45], following Friedman's [33] suggestion, argued that the question of the proper interest rate in the demand for money function should not be restricted to short-term versus long-term interest rates; rather, the entire term structure of interest rates should be used as the proper opportunity cost of money. This was done by first approximating the yield curve by a quadratic function. Heller and Khan then specified a demand for money equation in terms of their estimated term structure, real income and the lagged money variable.

Estimating their money demand equation over the 1960:3-1976:4 time period, they found their equation to be stable, using time trend regression and a cusum test to test the stability of their equation.

Porter and Mauskopf [68] reestimated the Heller and Khan equation to compare its forecasting error to that of Goldfeld's. Based on dynamic simulation over the 1974:3-1977:4 time period, they concluded that the cumulative prediction error of the HK equation was of the same order as the one produced by the standard Goldfeld equation.

The conclusion follows that it is doubtful whether Heller and Khan's proposition to expand the range of the opportunity cost of money to include the entire term structure of interest rates provided any improvement over the standard Goldfeld equation as far as the prediction of money demand was concerned.

The Issue of the Scale Variable

The empirical evidence with regard to this subject can be broken into two categories: Those investigators who use annual data for their study and those who utilize quarterly data. The empirical findings are quite different according to the data used in the studies. By and large, three measures have most frequently been used as the scale variable. The first of these is current income as a proxy for the volume of transactions to be affected by the money stock. Second is nonhuman wealth, measured as the consolidated net worth of the public; and, finally Friedman's permanent income proposed as a proxy for the wealth concept. Friedman [32] defined his permanent income as "those factors that the [economic] unit regards as determining its capital value or wealth: the nonhuman wealth it owns; the personal attributes of the earners of the unit, such as their training, ability, personality; the attributes of the economic activity of the earners, such as the occupation followed, the location of the economic activity, and so on" [p. 21].

Friedman [29] found that a demand for money as a function of permanent income without an interest rate variable appeared to fit United States data for the period 1870-1954. Friedman converted his demand for money function to express an equation for desired velocity. He concluded that his estimated velocity has the same secular downward trend and the same tendency to rise in booms and fall in slumps as the actual velocity.

Although his results suggested that the data support the theory, his results were subject to heated debate. For one thing, his estimated coefficients implied that the elasticity of velocity with respect to *permanent* income is negative. Since the secular trend of current income is positively related to permanent income, this implied that as current income grows the velocity falls. His results, consequently, suggested that the elasticity of the demand for money with respect to permanent income is greater than one or is equal to 1.81. As permanent income rises, the demand for money rises more than proportionately. According to these findings, Friedman concluded that money is a luxury good.

Meltzer [58] tested all three of the previously mentioned scale variables in log-linear equations that specified both M1 and M2 as dependent variables and also included a measure of the interest rate as the opportunity cost of holding money. Meltzer's results indicated that wealth was superior to both current income and permanent income. When both wealth and income were included in the equation, the income variable appeared to play no significant role in explaining the variation in money demand, whereas the wealth variable maintained the same significance in all tests. Meltzer also found that the elasticity of narrow money (M1) with respect to his measure of wealth to be close to one. This, of course, was in contrast to Friedman's finding of an elasticity of M2 with respect to permanent income of 1.81. Meltzer argued that Friedman's use of broad money (M2) and the absence of an interest rate from his equation were responsible for his high estimate of income elasticity.

Meltzer's results were supported in further tests carried out by Brunner and Meltzer [10]. Their study involved comparisons of the predictions of measured velocity derived from various formulations of the demand for money. Their findings suggested that income appeared to play a much smaller role than wealth while the test on nonhuman wealth versus permanent income yield less certain results. They concluded that nonhuman wealth was found to be slightly superior to permanent income and far more superior than current income in explaining variations in the demand for money.

Laidler [53], using year-to-year changes in data, rather than their annual level, compared the explanatory power of the alternative money demand functions. The money demand functions tested by Laidler were (1) a Keynesian specification with current income, (2) a Friedman-type permanent income specification, (3) an equation with nonhuman wealth defined as the transitory income (measured income minus permanent income), plus a constant fraction (marginal propensity to save) of permanent income. A short rate of interest was included and both M1 and M2 definitions of money were used as the dependent variable. Laidler's results, using data for the 1892-1960 time span, suggested both wealth and permanent income appeared to be able to explain more of the variation in the money balances than did the current income hypothesis.

So far, this section has concentrated on the studies that have used annual data rather than quarterly data. Heller [44] and Goldfeld [35] [36], using quarterly data, found contrasting results. Heller tested the explanatory power of measured income and wealth in an alternative money demand formulation. Both M1 and M2 were specified as dependent variables in equations that included income and the rate of interest, wealth and the rate of interest, or both income and wealth and the rate of interest. Measured income and wealth were both reported to be significantly different from zero in all equations when only one of these variables was used. However, when both were included in the same equation, only one retained its significance: measured income in the M1 equation and wealth in M2 equation. Heller interpreted his results as the evidence that demand deposits and time deposits are demanded for different reasons, cash and demand deposits for transactions motives and time deposits for the speculative or precautionary motive.

Additional evidence using quarterly data was presented by Goldfeld [35]. Using a log-linear model derived from a partial adjustment hypothesis, he compared the relative explanatory power of income, net worth and change in net worth in explaining holdings of money defined by M1. He concluded that, "at least for quarterly data, use of an income variable in the demand for money equation seems eminently sensible" (p. 615). He also argued that the absence of an income variable reduced the estimated speed of adjustment to a very low figure. In addition, the performance of Goldfeld's wealth equation in dynamic simulations was far inferior to that of his measured income equation. With respect to the change in net worth, the results were mixed. When income and the change in net worth were both included in the demand for money equation, both reported to be statistically significant and the change in net worth had indeed slightly improved the explanatory power of the original equation. However, the inclusion of this variable worsened its predictive ability. Goldfeld then argued ". . .the original equation is still to be preferred on its ex post performance" [p. 615].

In 1973, Goldfeld's [35] equation, despite reporting different results from those of the earlier studies, became the standard formulation of the demand for money. But starting in 1974, forecasts from his equation began to overpredict real money balances. Simulation of Goldfeld's equation reported a cumulative error for the 1974:1 to 1976:2 time period of almost nine percent. Goldfeld [36] and Benjamin Friedman [27] investigated the contribution of wealth in order to correct the equation difficiency. Goldfeld found that this change, substituting wealth for income, did not help in dynamic forecasting over the 1974-1976 time period. Benjamin Friedman found that when wealth replaced current income in the Goldfeld equation, the estimated coefficient on the lagged dependent variable became very large, implying a long adjustment lag.

Goldfeld [35], in his model, used real GNP as a proxy for transactions. His choice of real GNP has come under criticism since. GNP ignores transactions in financial assets and existing goods. Economists proposed two alternatives to GNP: (1) To use bank debits as a scale variable, and (2) to use the level of bank loans as a scale variable, e.g., Scadding and Judd [72]. Empirical results using these two alternatives for GNP implied that real GNP works as well as any other transaction variable, and business loans were either significant [36] or had the wrong (negative) sign [24].

The Stability of the Money Demand Function

The question of whether the demand function for money is stable remains as one of the most important issues in contemporary monetary theory. Scadding and Judd [71] argued that "what is being sought in a stable demand function is a set of necessary conditions for money to exert a predictable influence on the economy so that the central bank's control of the money supply can be a useful instrument of economic policy" (p. 993).

The stability of any empirical function depends upon the variables included in that function and, likewise, the criteria for choosing the *appropriate definition* of some variables, has been the stability of the demand function for that monetary measure. By and large, empirical investigation prior to 1973 showed that a stable demand function for money did indeed exist [35] [42].

In 1973, Goldfeld's equation, became the standard formulation. Forecasting outside the sample period, Goldfeld's equation showed no systematic error in such forecasts up to 1973. But, starting in 1974, forecasts from this equation began to overpredict real money balances. Dynamic simulations showed an error of nearly nine percent from 1974:1 to 1976:2. The monetary equations in the Federal Reserve Board's FMP Model gave similar results [72]. In light of this evidence, some economists argued that the demand for money had shifted down or the demand for money had become unstable.

If there were a shift in the demand for money, some economists [72] [46] associated the timing of this shift to a number of important financial and monetary developments. These include changes in regulations concerning interest rate ceilings on the deposits of commercial banks, innovation in short-term financial markets and increases in the rate of inflation and interest rates compared with previous years.

Evidence for the contributions of regulatory changes to the 1973-1976 money demand shift is rather scarce. However, Scadding and Judd [72, p. 998], based on unpublished Federal Reserve Board Staff Studies [68], [69], argued that the evidence suggests that the regulatory changes cannot by themselves explain the shift.

Discussion of the role of financial innovation concentrated mostly on the demand for money by firms, particularly on their demand for demand deposits. Two classes of innovation were distinguished here. First, the security repurchase agreement (RP), which involves the sale of a security with an agreement to repurchase the security at a specified future date and at a price which includes the accumulated interest. The risk in the RP market, for both parties, is assumed to be very low since the transactions are made for short maturities (mostly overnight) and because the transactions involve a high quality security which serves as collateral. The second class of these financial innovations was the cash concentration account. These accounts involve the transfer of excess cash balances from local banks to regional or money-center banks. These sorts of accounts reduced the size of transactions balances a corporation needed since cash inflows at one local account could be balanced against cash outflows at another local account [72, p. 999].

The empirical investigations on the impact of financial innovation on the demand for money can also be divided into two classes. The first class argues that the transactions cost between money and RPs are so low that RPs are effectively money. In this view, the solution, therefore, was to redefine M1 to include RPs [34] [78] [82]. The second class of investigations argues that the increased use of RPs has lowered transactions costs, but not so much that they should actually be included in the definition of M1. Instead, this class of economists argued that the shift in money demand could be removed by including the previous peak interest rates or income as proxies for reductions in transactions costs caused by financial innovation [70].

The results obtained by Garcia and Pak [34] indicated the demand for money is relatively more stable over 1974-1976 when the dependent variable includes RP than when it does not. While their estimated coefficients on income and the lagged dependent variable was not substantially different from those of Goldfeld, they found the root-mean-square error during 1974:1-1976:2 was reduced by 76 percent by including RPs in the money definition.

The empirical investigations using ratchet variables as proxies to reflect reductions in transactions costs also lend support to the view that this variable can help to account for the money demand shift. Ratchets on income and interest rate were used by Goldfeld [35] and rendered favorable results. The income-ratchet variable defined as the ratio of GNP to previous peak GNP when entered into the standard equation obtained a positive significant coefficient. In addition, the root-mean-square for M1 reduced from 48 percent to 3.1 percent. The interest rate ratchet defined as the previous peak rate on commercial paper when used both obtained a significantly negative coefficient and improved the simulations. When Goldfeld entered both of these ratchet variables with the marginal bank debits in his original equation he found the root-mean-square went down to two percent and the error in 1976:2 went down to 4.1 percent, a reduction of almost 60 percent compared to his original equation.

Scadding and Judd [72, p. 1002] have argued that, in order to decide which one of the above approaches is appropriate, one needs to have direct institutional evidence on the level of the transactions costs in the RP market, such as the degree of substitutability of RPs for demand deposits. Based on an unpublished investigation by Porter and Mauskopf [68], which provides the only estimate on transactions costs in the RP market, they argued the costs of going in and out of RPs are not so low and RPs probably do not dominate demand deposits. According to Scadding and Judd, this suggests that ratchet variables are to be preferred over adding RPs to M1. This conclusion can be further supported using Porter and Simpson's [69, p. 220] findings. They have argued that, for RPs to dominate demand deposits, the RP market must be active late in the day when firms know the amount of demand deposit balances needed to cover their transactions. However, they found most RP activity takes place in the morning. Nevertheless, most banks will not allow RPs to be reversed in the same day to meet unexpected cash needs [72, p. 1003].

However, despite the evidence supporting the ratchet variable formulation, any conclusion that can be drawn must be regarded as highly tentative. First, although the ratchet variable specification improved the forecasting ability of the original Goldfeld equation, it did not do so well in the ten years prior to 1974. This issue was addressed by Goldfeld [35] in simulations of his standard M1 equation. Second, other industrialized countries' money demand equations did not shift despite the fact that the 1973-74 high interest rate experience was worldwide. With the exception of Canada, foreign evidence does not suggest any instability of money demand after 1973, even though the rate of inflation and rates of interest abroad were similar to those in the U.S. [72]. Moreover, Boughton [7] attributed the shift in Canadian demand for M1 not to financial innovation, but to the move by the Canadian Monetary Authority in 1974 to a more flexible exchange rate system.

Summary

It was argued that almost all of the time series studies of the demand for money have used nominal interest rates, thus ignoring the effects of the income tax. Changes in tax rates alter the relative net-of-tax yields on different assets and, of course, the yields relative to cash. The consequences of ignoring tax changes results in an biased estimate of pure income and interest elasticities of demand for money. This is most obvious since the yield on money is untaxed while the net yields on all other assets fall as income and the marginal tax rate rise.

With regard to the relevant opportunity cost of holding money, although the majority of the studies favor the use of a short-term interest rate, the final judgment must await pending additional investigation, especially on the term structure of interest rates.

Using annual data, the evidence overwhelming points to the superiority of nonhuman wealth or permanent income over current income. Nevertheless, the time series studies using quarterly data indicated that current income was found to be the most appropriate scale variable. This conclusion was drawn based on the forecasting ability of the various formulations.

This review found no reason to suspect any instability in the demand for money for the pre-1973 period. However, the most likely cause of the observed instability in the demand for money after 1973 was found to be innovations in financial management.

This review also found that none of the alternative empirical specifications appeared to be superior to Goldfeld's equation in the sense of reducing the latter's post-1973 overprediction.

CHAPTER III

MODEL SPECIFICATION AND ECONOMETRIC ANALYSIS

Introduction

The purpose of this chapter is to outline the procedures used in analyzing the empirical data. This includes a discussion of the theoretical models of the demand for money, specification of the equations, statement of the hypotheses, econometric testing procedures, and the simultaneity and identification issues relating to the demand for money.

Theoretical Work

Baumol [4] and Tobin [80] use an inventory theoretic technique to model the transaction demand for money. Baumol's use of an inventory approach to the analysis of the demand for money has considerable intuitive appeal. Commodity inventories are held to bridge the gap between production and sales, money to bridge the gap between receipts and expenditures. Like the holders of inventories, holders of money are faced with the conflict between being caught short and the opportunity to earn some returns on alternative assets.

In its simplest form, the inventory model assumes only two stores of value, money with zero nominal rate of interest and an alternative interest-bearing asset, e.g., bonds. The model assumes a cost of transacting between the two alternative assets, i.e., brokerage fees, and a lack of synchronization between receipts and expenditures. The key element in the model is the interest rate differential between bonds and money that creates an interest opportunity cost of holding money. In this context, smaller money balances, on the average, are associated with high interest earnings or lower interest costs, but at the expense of higher transaction costs. Individuals are assumed to act so as to maximize interest earnings on the interest earning asset, net of transaction costs. Therefore, the average optimal real balances are determined by equality of the competing costs at the margin.

Mathematically, it can be shown that the implied average real balances are determined by the well-known square root formula, or:

$$\frac{M^d}{2} = \left(\frac{bT}{2i}\right)^{1/2} \qquad (1)$$

where T = a scale variable measuring transactions level

b = fixed brokerage fee, cost of transaction

i = the rate of interest

M^d = optimal nominal balances.

Transforming this equation into logarithmic form gives:

$$\text{Ln}M^d = 1/2 \text{ Ln } b + 1/2 \text{ Ln } T - 1/2 \text{ Ln } 2i \qquad (2)$$

The money demand elasticities are one-half with respect to transactions level and the cost of transactions, and negative one-half with respect to the interest rate on the earning asset.

The simple Baumol model has been improved and enhanced to include some additional assets and to account for some of its shortcomings. In particular, Feige and Parkin [25] included commodity stocks as an additional alternative store of value. The addition of commodity stocks into the model then required incorporation of a new cost of transacting for purchases of commodities with money and a nominal rate of interest for the commodity stores. The expected rate of inflation less the rate of depreciation and storage cost was taken as the relevant return for the commodity stores. According to this extended model, an increase in the expected rate of inflation raises the return on commodities and, therefore, reduces money holdings even if the nominal rate on the earning asset is held constant.

Yet, in another attempt to enhance the simple inventory model, Miller and Orr [59] applied the inventory approach to the demand for money in a stochastic context. While concentrating primarily on the firm's demand for money, they argued that a firm's net cash flow from receipts and expenditures was generated by a trendless random walk and, therefore, is entirely random. The firm's behavior in this framework is characterized by a two-parameter control limit policy. According to this inventory rule, the cash balance is allowed to fluctuate freely until it reaches either a predetermined lower bound or an upper bound. The firm then reacts with the appropriate portfolio transfer to restore the balance to a selected level of cash.

An important aspect of the stochastic inventory model is that the scale variable turns out to be the variance of daily net cash flow, with an elasticity of one-third. Their formulation also shows a negative interest rate effect with an elasticity of negative one-third and a positive effect of transaction costs with an elasticity of positive one-third. Therefore, the differences between the Miller and Orr elasticities and the Baumol elasticities involve a substitution of one-third for one-half.

However, subsequent extensions of the model, in particular by Brunner and Meltzer [9], show that under certain conditions the equation's elasticity coefficient does not take fixed values. The conditions include: the presence of different transfer costs into as opposed to out of money and also the presence of positive cash flows from sales as well as bond transfer. Under this condition, total money holdings, which are equal to the sum of amounts from both sources, depend on transaction levels, the interest rate, and all transfer costs. However, they show that, when all transfer costs exceed zero, the elasticity coefficients do not take fixed values. Therefore, while leaving the original variables intact, their analysis suggests that the elasticity values are an econometric question.

The Tax Rate and the Demand for Money

Using the inventory theoretic model as the point of departure, this section presents an analysis of the implications of including the tax variable in the demand for money. More specifically, first, the effects of inclusion of the tax rate on the arguments of the money demand equation--such as interest rates--are discussed, and second, an analysis of the nature of the relationship between changes in the tax rate and the subsequent changes in the optimal money holding is presented.

With regard to the first issue, the key element in the inventory approach to the transactions demand for money is the interest rate differential between bonds and money that creates an opportunity cost of holding money. Based on this model, individuals are assumed to act so as to maximize interest earnings on the interest earning asset, net of transaction costs. This implies that the average optimal real balances are determined by equating the competing costs at the margin.

In a country with proportional income taxes at rate <u>t</u>, for which interest receipts are taxable, the marginal interest cost of holding money is the after-tax rate of interest. This is obvious since the yield on money is untaxed while the net yield on all other assets falls as the marginal tax rate rises, thereby, reducing the yields on different assets relative to cash. This implies that it is the after-tax rate of interest that is relevant for individual constraints and therefore determines behavior.

The conclusion, therefore, follows that a fundamental aspect of taxes that has not generally been observed in empirical work on the topic is the need to work directly with after-tax rates of interest. This implies that one has to work with a net interest money demand specification.

Given the fact that the appropriate opportunity cost of holding money is the after-tax rate of interest, a net interest money demand equation is used to address the second question--the nature of the relationship between changes in the tax rate and the subsequent changes in the optimal money holding.

Consider the following demand for money equation expressed in terms of the net interest rate and an income variable:

$$M^d = M^d\ (r_N,\ y),$$

where $r_N = r(1-t)$, r = nominal rate of interest, t = marginal tax rate, y = scale variable and Md = optimal demand for money. In this context, one can easily see:

$$\frac{dMd}{dt} = \frac{dMd}{dr_N} \cdot \frac{dr_N}{dt}$$

However, $dr_N/dt = -r$, therefore

$$\frac{dM^d}{dt} = -r \cdot \frac{dM^d}{dr_N}$$

Since dM^d/dr_N is negative, the conclusion follows that dM^d/dt is positive, or as tax rate increases, so does the transaction demand for money. This positive relationship between the tax rate and the optimal demand for money is due to the fact that the true opportunity cost of holding money--net rate of interest--and the tax rate are inversely related.

In addition to this direct relationship between the tax rate and the opportunity cost of holding money, there also exists another equally important but less obvious relationship between taxation and the degree of risk-taking known as the risk-sharing factor. This is the Domar-Musgrave [21] effect. The nature of the relationship is argued to be *indirect*, through the effects of taxation on risk taking. This analysis crucially depends upon the investor's ability to offset losses. If losses cannot be offset, meaning capital losses are not tax deductible, then the investor carries the entire burden of risk. In this case, the tax reduces the yield but leaves the risk unchanged. This, in turn, reduces the compensation per unit of risk taking, as defined by the ratio of yield over risk. Risk-taking becomes less attractive and there is some incentive on the part of the investor to hold more money or take less risk. This is the substitution effect of taxation on risk-taking. Further, the tax also reduces the interest income and to restore it more risk is taken, i.e., the proportion of total assets held in riskless asset (or money) is reduced. This is known as the income effect of taxation on risk-taking. The final effect in this case is ambiguous, depending upon which of the two opposing forces prevail.

With the full loss offset provision, imposition of taxation on interest income reduces both yield and risk by the same proportion, therefore leaving no incentives to take less risk as the substitution effect of taxation on risk-taking disappears. However, to compensate for the loss of interest income, more risk is taken by investing more in risky assets at the expense of holding less money. This suggests that if a complete offset of losses is possible then there exists an inverse relationship between the tax rate and the demand for money. This is, of course, the risk-sharing factor.

As is obvious, assuming full loss offset is in effect, the final effect of the tax rate on the demand for money depends upon which of these two opposing forces--the direct substitution effect or the indirect risk-sharing effect--dominates. If the direct substitution effect outweighs the indirect risk-sharing effect, then one expects to get a positive relationship between the tax rate and the demand for money. If the risk-sharing effect is the dominant effect, then an inverse conclusion is expected. Given the ambiguous nature of the final effect, this study remains uncertain about the relationship and makes it an empirical question. In order to address this issue and to empirically identify the dominant factor amongst the two opposing forces, consider the following equation:

$$\text{Ln } M^d = \text{Ln } a + B_1 \text{ Ln } r(1-t) + B_2 \text{ Ln } Y + \varepsilon_i$$

where $\underline{r(1-t)}$ = the net rate of interest, $\underline{Y}$ = the scale variable and $\underline{M^d}$ = real demand for money.

This equation explicitly accounts for the substitution effect since the tax rate is incorporated into the equation only through its effect on the opportunity cost of holding money. In order to include the risk-sharing factor into this equation, it is adjusted to give:

$$\text{Ln } M^d = \text{Ln } a + B_1 \text{ Ln } r(1-t) + B_2 \text{ Ln } Y + B_3 \text{ Ln } (1-t) + \varepsilon_i$$

In this context, the net rate of interest or r(1-t) captures the direct substitution effect--as suggested by the inventory theoretic model--and (1-t) picks up any residual effect or the risk-sharing effect, as suggested by Domar-Musgrave and Tobin. In order to identify the dominant effect, this equation can be expanded to give:

$$\text{Ln } M^d = B_0 + B_1 \text{ Ln } r + B_2 \text{ Ln } Y + B_4^* \text{ Ln } (1-t) + \varepsilon_i$$

where $B_4^* = B_1 + B_3$.

Based on Domar-Musgrave and Tobin, $B_3 > 0$, since $\frac{\partial M^d}{\partial t} < 0$ or $\frac{\partial M^d}{\partial (1-t)} > 0$. It is also expected that B_1 carries a negative sign. In this framework, then, $B_4^* \lesseqgtr 0$, for $B_3 \lesseqgtr B_1$. In other words:

1. If B_4^* is positive, then $B_3 > B_1$, or the risk-sharing effect outweighs the substitution effect.
2. If B_4^* is negative, then the substitution effect is the dominant factor.
3. If $B_4^* = 0$, then the two opposing effects are offsetting.

Model Specification

An Aggregate Demand for Money

A conventional formulation of the money demand function based on the transaction demand for money has real money balances related to the interest rate on the relevant substitute assets and some measure of economic activity, such as income or wealth. Thus:

$$\text{Ln } M^d = \text{Ln } a + B_1 \text{ Ln } r + B_2 \text{ Ln } Y \qquad (3)$$

or

$$\text{Ln } M^d = \text{Ln } K + \gamma R + \alpha \text{ Ln } Y \qquad (4)$$

Equations (3) and (4) are different in the sense that (3) includes the logarithms of interest rates rather than the interest rates themselves. Inclusion of the logarithms of interest rates would imply that the corresponding regression coefficients are interest elasticities. This would assume that elasticities are the same at all levels of interest rates.

Equation (4), however, implicitly assumes that the absolute rather than percentage change in interest rates is what matters for the demand for money [31, p. 264]. This, of course, means that whether interest rates are high or low, a one-percentage point change in interest rate produces the same percentage change, in the opposite direction, in the quantity of money demanded and, therefore, assumes that slopes rather than elasticities are the same at all levels of interest rates.

Friedman and Schwartz [31, p. 266], argued that it is more appropriate to use a constant slope (semilog) rather than constant elasticity (log-linear) specification on the grounds that a doubling of an interest rate of one percent is not as much of a stimulus to reduce cash balances as is a doubling of an interest rate of ten percent. Therefore, constant elasticity should be ruled out. Friedman and Schwartz's estimation of semilog equation provided favorable results. Despite their finding, the question regarding the appropriate specification requires a thorough empirical analysis before a firm conclusion can be drawn.

Other approaches toward the demand for money emphasize speculative or utility analysis in addition to the transaction motive, for instance Tobin [81] and Patinkin [63]. Although these approaches lead to more complicated specifications of the demand for money, they are broadly consistent with the general form of equation (3). Goldfeld [35], using quarterly data, made several modifications to this basic equation. Using equation (3), he introduced the concept of desired, as opposed to actual, money balances and specified a partial adjustment mechanism by including a lagged, as well as current, dependent variable and came up with an equation in the following form:

$$\begin{aligned} \text{Ln } M_t = \gamma \text{ Ln } a + \gamma B_1 \text{ Ln RCP} + \gamma B_2 \text{ Ln RTD} \\ + \gamma B_3 \text{ Ln } Y + (1-\gamma) \text{ Ln } M_{t-1} \end{aligned} \quad (5)$$

Where M_t = real money balances

Y = real GNP

RCP = the rate on commercial paper

RTD = the rate on time deposits

γ = the speed of adjustment. This measures the rate at which adjustments are made to bring actual money holding in line with the desired level.

Using equation (5) and applying the marginal income tax rates, t, the nominal interest rates in equation (5) can be transformed to the net interest rates, i.e., interest rates after taxes, in the following manner:[1]

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[1]The Goldfeld model is used as the point of departure for the purpose of model specification. Whether this model is the best specification is subject to debate. This specification is tested against some alternative models and results are reported in Chapter VI.

$$\text{Ln } M_t = \gamma^T \text{ Ln } a + \gamma^T B_1{}^T \text{ Ln } [RCP\ (1-t)] + \gamma^T B_2{}^T \text{ Ln } [RTD\ (1-t)] + \gamma^T B_3{}^T \text{ Ln } Y_t + (1-\gamma)^T \text{ Ln } M_{t-1}. \tag{6}$$

Where superscript T denotes the estimated coefficient for the tax-adjusted equation. The estimated coefficient for $B_1{}^T$ and $B_2{}^T$ then would provide the short-run elasticity of the demand for money with respect to the net rates of interest.

In the context of equation (6), the long-run elasticity of demand for money with respect to the interest rate variables is influenced by two factors: first, variations in the nominal interest rate as well as income; second, variation in the tax rate. This is the purpose of this dissertation, then, to analyze the differences between these estimates and those of the conventional formulation.

Two rates of interest are included in the model, RCP to represent the market rate of return on risky assets and RTD to account for the yield on riskless assets. Specifying a demand for money equation in terms of the bond rate of interest alone results in confining the model with the allocation of wealth between only risky assets (bond) and riskless liquid assets, in general. The purpose for inclusion of RTD is to be able to account for the division of liquid assets between money, defined as means of payment and risk-free assets which yield a nominal return but are not generally accepted as a medium of exchange, e.g., savings deposits, since it is the former which is most generally defined as money and not the latter.

Household Demand for Money

In order to formulate a testable specification for the household demand for money, Baumol's inventory theoretic framework is used as the point of departure. Based on this model, average optimal real cash balances are determined by the equality of the competing costs at the margin. The cost of holding money for the household sector should be represented not by the nominal rate of interest but rather by this rate net of taxes.

With regard to the cost of transacting between interest bearing assets and money in the case of the household sector, these costs are "largely nonpecuniary" and therefore in many cases unobservable. The nonpecuniary nature of these costs arises from the fact that they are largely intangible. For instance, in the case of the household, these costs are mostly defined to include such elements as time for such things as more frequent trips to the bank and the time required to balance the checkbook. However, it is not the nonpecuniary nature of these costs which is solely important, but rather the fact that these costs are not tax-deductible. That is, while the cost of holding money should be adjusted for the marginal tax rate, no such adjustment can be made to the costs of holding interest bearing liquid assets or, in general, to the costs of transacting between the alternative assets [50, p. 684]. Otherwise, the income tax is irrelevant, since it reduces at the margin both the costs and returns by the same proportion, therefore leaving the optimal money balances unchanged.[2]

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[2]For a complete discussion, the reader should see Ira P. Kaminov, "The Household Demand for Money," Journal of Finance, 24 (September 1969), 679-696.

The second aspect of the transaction costs is that they are unobservable. For the purpose of empirical tests, this dissertation assumes that these costs are institutionally fixed.

Since the Goldfeld [35] model is used as the point of departure and of contrast for the results to be presented for the aggregate demand for money equation, this dissertation used a model that is similar to the one used by Goldfeld to incorporate the ideas presented for the household money demand equation.

Goldfeld found that the same type of specification used for aggregated money demand worked equally well for the household sector. In light of this finding, the household demand for money is specified as follows:[3]

$$\text{Ln } M1H_t = \text{Ln } a + B_1 \text{ Ln } CONS_t + B_2 \text{ Ln } RCP_t^T + B_3 \text{ Ln } RTD_t^T + B_4 \text{ Ln } M1H_{t-1} \tag{7}$$

Where M1H = households' total holding of currency and demand deposits, $CONS_t$ = real consumption expenditures at time t, RTD_t^T = rate on time deposit after adjusted for taxation, RCP_t^T = after-tax rate of interest of commercial paper, and $M1H_{t-1}$ = M1H lagged one quarter.

This equation is fitted to empirical observations of variables, and the results are compared with the non-tax specification.

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[3]One can alternatively specify a semi-log model. Since Goldfeld's equation is used for the aggregate model, the same formulation is used for the household sector. If the tests in Chapter VI result in superiority of semi-log or any other formulation over Goldfeld's, then that specification will be used to replace Goldfeld's equation for both the aggregate and household sectors.

Business Demand for Money

Before describing the model to be used for this sector, it is helpful to start with the recognition that the inventory theory has different implications for the business and household sectors.

Kaminov [50] argues that the business sector's responsiveness to the short-term rate of interest appears to be very sluggish. He uses evidence reported by the National Industrial Conference Board. This indicates that a considerable amount of investment in fixed plant must be made by corporations before they can actually economize on money balances. These expenses include such elements as fixed hiring costs to increase the staffs of comptrollers' offices, the cost of operating new accounting systems and the cost of retraining current employees in money economizing techniques. Based on these results, he concludes that for firms to engage in significant cash economizing it is necessary that they be convinced that a high short-term interest rate will prevail for long periods of time [p. 684].

This view was supported by James Dussenberry [23]. According to him, a five-year moving average of past short-term interest rates is a good candidate to measure the opportunity cost of money in the case of the corporate demand for money.

The foregoing discussion, therefore, suggests that there may be a very sluggish response to changes in the short-term interest rate in the case of the business demand for money.

Nevertheless, for the purpose of this dissertation, the most important aspect of the business demand for money is the transactions cost. In the case of the household sector, the transactions costs are of a nonpecuniary nature and, therefore, are not tax deductible. While this argument is completely in line for household demand for money, it does not seem to be as appealing in the case of the business sector. For corporations, the costs of cash economizing are largely financial costs and, therefore, tax deductible. This, of course, implies that the income tax would reduce both the marginal costs and returns to cash economizing by the same proportion and, therefore, leave money balances invariant with respect to the tax rate. This suggests that the tax variable does not belong in the business demand for money; and if the tax variable is indeed included as an explanatory variable it would not enhance the explanatory power of the equation.[4]

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[4]This point can be shown by the following cost function.

$$\text{Total Cost} = \frac{b(1-t)\cdot T}{c} + \frac{r(1-t)\cdot c}{2}$$

Where c = optimal cash holdings. The minimization of the total cost function involves:

$$\frac{d\ (\text{total cost})}{dc} = \frac{-b(1-t)\cdot T}{c^2} + \frac{r(1-t)}{2}$$

or

$$\frac{-b(1-t)\cdot T}{c^2} + \frac{r(1-t)}{2} = 0$$

$$c^2 = \frac{2b(1-t)\cdot T}{r(1-t)}$$

$$c = \sqrt{\frac{2b(1-t)\cdot T}{r(1-t)}}$$

$$\frac{c}{2} = \sqrt{\frac{b(1-t)\cdot T}{2r(1-t)}}$$

It is obvious that the term (1-t) cancels, therefore leaving the firm's demand for money invariant with respect to the tax rate.

Based on the conventional empirical models [5] [75] [85] [60] [62] and using Goldfeld's specification as the point of departure, the following equation is formulated:[5]

$$\text{Ln M1B} = \text{Ln } \alpha + B_1 \text{ Ln } SALE_t + B_2 \text{ Ln } RCP_t^T + \qquad (10)$$
$$+ B_3 \text{ Ln } M1B_{t-1}$$

Where $M1B_t$ = business holdings of demand deposits and currency, $SALE_t$ = manufacturing and trade sales, as a proxy for the transactions variable, RCP^T_t = interest rate of commercial paper after adjusting for tax rate, and $M1B_{t-1}$ = M1B lagged one quarter.

This specification provides a direct comparison with the non-tax specification which appears as

$$\text{Ln } M1B_t = \text{Ln } 1 + B_1 \text{ Ln } SALE_t + B_2 \text{ Ln } RCP_t + B_3 \text{ Ln } M1B_{t-1} \qquad (11)$$

These two equations are fitted to empirical observations of variables and the results are used to investigate the empirical dimension of incorporating income taxation into the business demand for money.

Statement of Hypothesis

The discussion presented, suggests that earlier empirical works on the topic have misspecified the demand for money equation. The misspecification arises from the fact that, by using the nominal rate of interest as the proxy for the opportunity cost of holding money, the

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[5]Although inventory theory generated testable specifications, the empirical work on the topic provided no consensus as to what the relevant variables are. For instance, Ben-Zion [5] and Sprenkle [75] used nominal sales while Whalen [83] used a ratio of sales to total assets as the proper transactions level. With respect to the rate of interest, Ben-Zion [5] used the cost of capital as a proxy for interest rate while Miller and Orr [60] used a long-term rate. Finally, the concept of transaction cost was omitted in most of the empirical work with the exception of Sprenkle [75] and Orr [62].

earlier works have ignored: (a) the role of the income tax structure and the point that interest receipts are taxable, and (b) the effect of the income taxation on optimal bond holding as suggested by Tobin [81] and others [21].

In the area of the demand for money, like any other area of research, economic theory should be used as a guide toward identifying the most relevant choice of variables. The point that the investor compensates for the taxation on investment income by increasing holdings of the risky asset is well established if one considers the effect of taxation on the portfolio selection decisions of expected utility maximizing investors. This implies that the imposition of income taxes alters the optimal asset combination through its effect on risk and yield of risky investment, as well as its effect on the true opportunity cost; in a country with income taxes, for which interest receipts are taxable, it is the after-tax rate of interest that enters individual constraints and determines behavior.

In the case of the household sector, the asymmetry between the treatment of the costs and returns by the tax laws provides the theoretical justification for including the tax variable in the demand for money. This suggests that for this sector the null hypothesis (H_0) can be stated as: The tax-adjusted specification is the true model while the alternative hypothesis (H_1) is: The non-tax specification is the true model.

In the case of the business demand for money, inventory theory suggests the opposite. For corporations, the income tax reduce both the marginal cost and marginal returns to cash economizing by the same proportion, thus leaving money balances invariant with respect to the tax rate. In light of this discussion, for business demand for money, the null hypothesis (H_0) is stated as the non-tax specification is the true model, while the alternative hypothesis (H_1) is that tax-adjusted specification is true model.

For the aggregated demand for money equation, two testable specifications were formulated. According to Tobin [81], the imposition of a tax, t, levied on interest income and capital gains, with a complete loss offset provision in effect, would reduce the expected return and the risk, per dollar of consols, by the same proportion. As a result of this, the opportunity locus of risk and expected return remains constant. However, the imposition of taxation causes the risk-consol line to rotate to the left. This implies, that the individual's income, however, declines; and to restore it the demand for money at any market rate of interest is reduced.

The following discussion, therefore, suggests a demand for money specified in terms of nominal rate of interest will overestimate the actual money holding. In light of this argument, the null hypothesis (H_0) in the case of aggregated demand is specified as: The non-tax specification is the true model, while the alternative hypothesis (H_1) is: The tax-adjusted specification is the true model.

Income Tax and the Elasticity Estimates

All of the time series studies of the demand for money use the observed market interest rate, and thus have ignored the effects of the income taxation. In a country with income taxes, changes in tax rates alter the relative net of tax yields on different assets and, more importantly, the yields relative to cash. Since the yield on money is untaxed while the net yields on all other assets fall as income and the marginal tax rate rise, ignoring tax changes results in an overestimation of pure income and interest elasticities of the demand for money.

The overestimation of pure income and interest elasticities of the demand for money arises from the fact that the earlier empirical works on the topic have largely misspecified the money demand equation. The two most common types of misspecification occur when (1) a relevant variable is omitted from the regression, and (2) an irrelevant variable is added to the equation. The former has occurred in the empirical investigations of the demand for money.

In order to investigate the effects of taxes on the income and interest elasticities of the demand for money consider the following two models [48, pp. 187]:

$$Y_i = X_1 B_1 + X_2 B_2 + \varepsilon_i \tag{16}$$

$$Y_i = X_1 B_1^* + \varepsilon_i^* \tag{17}$$

where X_1 is an N×K matrix of independent variable observations and X_2 is an N×1 column vector of omitted independent variable observations. Assume that the true model is given by equation (16), while the regression model is given by equation (17). The B_1^* is estimated as

$$\hat{B}_1^* = (X_1'X_1)^{-1} X_1'Y_i \tag{18}$$

Substituting for Y_i as defined by equation (16) into equation (17) results in the following:

$$\hat{B}_1^* = (X_1'X_1)^{-1} X_1' (X_1B_1 + X_2B_2 + \varepsilon_i)$$

$$\hat{B}_1^* = (X_1'X_1)^{-1} X_1'X_1B_1 + (X_1'X_1)^{-1} X_1'X_2B_2 + (X_1'X_1)^{-1} X_1' \varepsilon_i$$

or

$$\hat{B}_1^* = B_1 + (X_1'X_1)^{-1} X_1X_2B_2 + (X_1'X_1)^{-1} X_1' \varepsilon_i \qquad (19)$$

Taking the expectation of equation (19) renders

$$E\ (\hat{B}_1^*) = B_1 + (X_1'X_1)^{-1} X_1'X_2B_2 \qquad (20)$$

since $E(\varepsilon_i) = 0$, given the assumptions of the classical linear model.

From equation (9) it can be seen that since there is no reason a priori that the second term equals to zero, the estimated value of $\hat{B}_1^*$ from the misspecified equation, yields a biased estimate of B_1. In the case where the equation is in logarithm form, the estimated value of B_1^* is interpreted as the elasticity of Y with respect to the independent variables. Therefore, the foregoing conclusion suggests that, when working with log-linear specification, omission of a relevant variable yields biased estimates of the true elasticities.

It can be recalled that the conventional demand for money was adjusted for the tax-variable by including one minus the marginal tax rate rather than the marginal tax rate in the equation; accordingly, the X_2 variable in equation (20) refers to (1-t). According to equation (20), the direction of bias depends upon the estimated slope coefficients associated with the regression of the omitted variable on all included variables, as well as the sign of the coefficient B_2 from the true model. The relationship between the omitted variable and all other included variables can be captured by the following regression model:

$$Ln\ (1-t) = c_0 + c_1\ Ln\ r + c_2\ Ln\ Y + \varepsilon$$

Given this regression model, equation (20) can be written in the following form:

$$E\ (\hat{B}^*_1) = B_1 + \begin{bmatrix} c_0 \\ c_1 \\ c_2 \end{bmatrix} B_2 \tag{21}$$

With respect to the direction of bias for income elasticity, it is clear that an increase in the tax rate results in a reduction of income. Consequently, one expects a positive relationship between income and (1-t). Therefore, for income elasticity the following relationship exists

$$\overset{+}{E(\hat{B}^*_{1Y})} = \overset{+}{B_{1Y}} + \overset{+}{c_2}\overset{?}{B_2}$$

It is clear that nothing can be said about the direction of bias because of the ambiguity of the B_2 parameter. If the substitution effect outweighs the risk-sharing effect, then B_2 is negative and, therefore, the omission of the tax-variable results in an underestimation of the income elasticity. However, if the risk-sharing effect dominates, the direction of bias is reversed. It is clear that the question about the direction of bias is an econometric issue.

With respect to the interest elasticity of the demand for money, the following relationship exists:

$$\overset{-}{E(\hat{B}^*_{1i})} = \overset{-}{B_{1i}} + \overset{+}{C_1}\overset{?}{B_2}$$

which implies that $|E(\hat{B}^*_{1i})| \gtreqless |B_{1i}|$, for $C_1 B_2 \gtreqless 0$.

In this case, it is also clear that no definite conclusion can be made with respect to the direction of bias. This is partially due to the fact that, theoretically, the sign of the C_1 parameter, or the nature of the relationship between $\underline{t}$ and $\underline{r}$, is not predictable.

The foregoing analysis therefore suggests that ignoring the effect of income taxation on the demand for money results in biased estimates of pure income and interest elasticities of the demand for money. The direction of bias, however, remains an econometric question.

Testing Procedures

It has been argued that the inventory theoretic model indicates the need to work directly with the after-tax rates of interest. For the purpose of model specification this in turn implies the need to work with a net interest money demand formulation. In this context, the theoretical proposition set forth is: The net interest money demand equation is the correct specification.

The proposition that, in a country with income taxes, the appropriate opportunity cost of holding money should be represented by the after-tax rate of interest is theoretically plausible and realistic. But a theory is not judged by its plausibility, but by how well it can predict the actual behavior in the market place; in other words, by its applicability. This means, although the transactions demand for money implies that the correct specification is in terms of the after-tax rate of interest, this proposition should be tested to see whether it represents the true model, given the historical observation of the data. This is the truth of this specification should be tested against the alternative formulation. The purpose of this section is to outline in detail the statistical tests that are used to compare the tax-adjusted version of the demand for money against the conventional form, or the non-tax specification.

One test of the relative abilities of the two specifications of the money demand equation would be to compare the sum of squared residuals. One can also reestimate the two equations over a shortened period and then compare their relative forecasting abilities over the remainder of the sample period. In addition to these basic tests, one can also use the procedure proposed by Pesaran and Deaton (P-D) [65]. Their testing procedure allows one to test the truth of a multivariate regression specification, when there exists a nonnested alternative hypothesis. P-D's procedure is primarily based on the theoretical work of Cox [16]. According to Cox, assume the hypothesis to be tested, H_1, and the alternative, H_2, is given by:

$$H_1: \quad Y = X B_1 + U_1 \tag{12}$$

$$H_2: \quad Y = Z B_2 + U_2 \tag{13}$$

where Y is the vector of n observations on the dependent variable, U_1 and U_2 are vectors of normally and independently distributed error terms, X and Z are matrices of observations on the independent variables, and B_1 and B_2 are vectors of parameters to be estimated.

Assume α_1 and α_2 are the complete set of parameters under H_1 and H_2 and L_1 (α_1) and L_2 (α_2) represent the log likelihood functions of H_1 and H_2, then the Cox statistic (T_1) for testing H_1 against H_2 is given by:

$$T_1 = \hat{L}_{10} - n \left[\underset{n \to \infty}{\text{Plim}} \left(\frac{\hat{L}_{10}}{n} \right) \right] \alpha_1 = \hat{\alpha}_1$$

where n = number of observations, Plim = the probability limit when H_1 is true, $\hat{L}_{10} = L_1 (\hat{\alpha}_1) - L_2 (\hat{\alpha}_2)$ and $\hat{\alpha}_1$ and $\hat{\alpha}_2$ = the maximum likelihood estimators of α_1 and α_2 under H_1 and H_2. Given H_1 is true, Cox shows that T_1 is asymptotically normally distributed with mean zero and variance $V(T_1)$.

Pesaran and Deaton's technique is primarily concerned with the derivation of specific expressions for T_1 and $V(T_1)$. To derive T_1 the following steps should be taken:

1. H_1 and H_2 should be estimated and $\hat{B}_1$, $\hat{B}_2$, $\hat{\sigma}_1^2$ and $\hat{\sigma}_2^2$ calculated following the usual estimation technique where $\hat{\sigma}_1^2$ and $\hat{\sigma}_2^2$ are defined as the estimated residual variance from H_1 and H2.
2. Let $\hat{\sigma}_{21}^2$ be the estimated residual variance from the regression of X $\hat{B}_1$ on Z.
3. Define $\hat{\sigma}_{10}^2 = \hat{\sigma}_1^2 + \hat{\sigma}_{21}^2$.
4. T_1 is then

$$T_1 = \frac{n}{2} \text{Log} \left\{ \frac{\hat{\sigma}_2^2}{\hat{\sigma}_{10}^2} \right\}$$

For the derivation of $V(T_1)$ they argue that:

$$\hat{V}(T_1) = \frac{\hat{\sigma}_1^2}{\hat{\sigma}_{10}^4} \cdot e'_{121} \, e_{121}$$

where e_{121} is the vector of OLS residuals in the regression of e_{21} (the residuals from the regression of X $\hat{B}_1$ on Z) on x. Clearly then, $e'_{121} \, e_{121}$ is the residual sum of squares from this last regression.

Since T_1 was argued to be asymptotically normally distributed with mean zero and variance $V(T_1)$, it is obvious that, given the truth of H_1,

$N_1 = T_1/\hat{V}(T_1)^{1/2}$ is asymptotically distributed as N(0,1). Similarly, one can compute T_2, $\hat{V}_2$ (T_2) and N_2 when H_2 is assumed to be the correct model.

The result of this test can be classified according to the four possible outcomes:

(1) Do not reject H_1 and reject H_2 when $|N_1| < 1.96$ and $|N_2| > 1.96$

(2) Reject H_1 and do not reject H_2 when $|N_1| > 1.96$ and $|N_2| > 1.96$

(3) Reject both H_1 and H_2 when $|N_1| > 1.96$ and $|N_2| > 1.96$

(4) Do not reject H_1 and H_2 when $|N_1| < 1.96$ and $|N_2| < 1.96$.

Alternatively, Davidson and MacKinnon (D-M) [18] have proposed a simple method for testing model specification in the presence of an alternative non-nested model. Consider the following two specifications:

$$H_0: \quad Y = X\,B_1 + U_2$$

$$H_1: \quad Y = Z\,B_2 + U_2$$

According to Davidson and MacKinnon, if the null hypothesis is that H_0 is the true model, then the test equation is:

$$Y = X\,B_1 + \alpha\,Z\,\hat{B}_2$$

where $Z\,\hat{B}_2$ is the predicted value for Y from estimating H_1. According to Davidson and MacKinnon, the true value of $\underline{\alpha}$ is zero when H_0 is true. Consequently, if the estimated value of α does not differ significantly from zero, H_0 would not be rejected. To test the truth of H_1, however, one must estimate:

$$Y = Z\,B_2 + \alpha\,X\,\hat{B}_1$$

where $X\,\hat{B}_1$ is the predicted value of Y from estimating H_0. If the estimated value of α does not differ significantly from zero, then one cannot reject the hypothesis that H_1 is the true model.

The the tax-adjusted demand for money equation will be tested against the non-tax specification using both the (P-D) and the (D-M) testing procedures.

Identification and Simultaneity

The conventional approach toward estimating the demand for money is to use a least squares estimation model. This practice is justified only if one assumes that each of the independent variables in the model is uncorrelated with the error term. In other words, the use of a least squares regression model is warranted if there exists a one-way causation from the independent to the dependent variable, with no direct feedback. In particular, the interest rate must be assumed to influence the real supply of money, but the stock of money must not influence this variable.

A close examination of economic theories suggests that one way causation from the interest rate to the real quantity of money demanded is not warranted and causation is not unidirectional. This, in turn, implies that the estimate of the coefficients derived by least squares regression methods is inconsistent [6, p. 280].

The following discussion suggests the necessity of working within a complete structural model of demand and supply functions in which the demand for money equation will be estimated as one element in a multi-equation model. The majority of the empirical work that has assumed simultaneity between money supply and money demand have concluded that the system estimation of the money-demand equation did not result in estimates significantly different from those produced by least squares regression methods, i.e., [77], [9], [35], and [20]. In fact, Goldfeld [35] and Dickson and Starleaf [20] reported that the two-stage least-squares estimates of the parameters are similar to single-equation estimates, a result consistent with the inference that the simultaneity-equation biases are not significant enough to distort the parameter estimates derived by the ordinary least squares method [57, p. 212].

Cooley and LeRoy [15], however, argue that Goldfeld's estimation of the parameters using the two-stage least squares method is inconsistent. According to them, Goldfeld's conclusion with respect to the simultaneity equation biases suggests that his estimates derived from the ordinary least squares and the two-stage least squares methods have "approximately the same inconsistency" [p. 838]. The inconsistency arises from Goldfeld's formulation of instrumental variables.

> The method of instrumental variables involves the search for a new variable Z which is both highly correlated with the independent variable X and at the same time uncorrelated with the error term in the equation [66, p. 179].

It is clear that Goldfeld's use of the discount rate as one of the instrumental variables is objectionable based on this definition. According to Cooley and LeRoy [15], the discount rate is a suitable instrument only if one assumes that its correlation with the error is low. They argue

> On the traditional interpretation the Federal Reserve uses the discount rate as an instrument to influence the money stock, implying that it will surely respond to random shifts in money demand [p. 838].

Therefore, they conclude that "We are left unconvinced that demand has been consistently estimated" [p. 838].

Accordingly, the simultaneity issue cannot simply be dismissed on the grounds that other investigators have concluded that the simultaneity equation biases are not large enough to distort the parameter estimates from single-equation, implying that least squares estimation is justified. The simultaneity issue is taken into account in the two-stage least squares estimation.

The second aspect of the identification problem is the question of exogeneity of the money supply. The conventional approach to the demand for money is to relate the supply of money to the arguments of the demand for money function. Laidler [54] argues that ". . .question concerns what in practice are the most frequent sources of disturbance and which variables usually bear the brunt of subsequent adjustments" [p. 237]. According to Laidler, in the case of a given individual agent, one can treat the general price level, the rate of interest, and individual income and wealth as given. In this context, there probably would be little objection to argue that the individual's holding of cash balances varies as a consequence of his own choices. Therefore, it would be reasonable to specify an individual's demand for money in the conventional way. However, to argue that the economy as a whole is a mere representative of an individual agent, "is to commit a fallacy of composition" [p. 237].

Laidler [54] goes on to argue that financial market behavior based on the credit market hypothesis suggests that the money stock rather than the interest rate may be taken as the exogenous variable. Starting with a full portfolio equilibrium, he analyzes the behavior of the financial market to the monetary authority's decision to raise the price at which they are willing to buy securities. According to Laidler, this action by the monetary authority leads to an attempt by the nonbank public to substitute physical capital for securities. In order to be able to do so, the nonbank public attempts to acquire necessary purchasing power by offering securities to the banks. The banking system then, as a whole, will be able to supply that money by offering securities to the authorities. This excess amount of money is created not because the nonbank public as a whole wants to hold it, but because the public wants to use it to purchase physical capital. However, once created, this excess money would set in motion "streams of expenditure," and therefore affects the arguments of the demand for money, namely, prices, income, and consequently money holdings. In this case, it is clear that the demand for money responds passively to variations in the supply of money, rather than vice versa and according to Laidler, "Such a process is not properly captured in conventional formulations. . ." [p. 236].

The empirical works on the exogeneity of the money supply have provided mixed results. For instance, Sims' [74] investigation with respect to the relationship between GNP and the money supply showed that "causality does not run one way from GNP to money" [p. 541] and based on this he concluded "One clearly should not estimate a demand for money relation from these data, treating GNP as exogenous with money [supply] on the left-hand side" [p. 550].

On the other hand, Mehra [57] tested the exogeneity of money supply in the money-demand equation and concluded

> The usual practice of regressing real money on real income and nominal interest rates in a single-equation estimation is validated, and there is nothing to be gained by estimating money-demand equations with real income or interest rates as the left-hand-side variable" [p. 227].

The foregoing discussion suggests little work has been done to incorporate formal exogeneity test procedures into the demand for money specification. By and large, the assumptions underlying the endogeneity of the money supply are imposed *a priori* without any statistical rationalization. Therefore, this dissertation will test to see if money supply is indeed endogenous.

CHAPTER IV

EMPIRICAL RESULTS

Introduction

Based on the theoretical models discussed in the preceding chapters, it was argued that the previous work on the topic has misspecified the demand for money equation. The misspecification arose from the fact that the previous works had failed to incorporate the income taxation into their specification of money demand equation. The theoretical work developed by Tobin [81], Domar and Musgrave [21] and others suggested that investors compensate for the tax rate on investment income by increasing holdings of the risky asset. This, in turn, implied that a tax of this kind would reduce his demand for cash at any market rate of interest.

In order to correct for this misspecification, the nominal rate of interest is replaced by this rate net-of-taxes. In a country with income taxes, for which interest receipts are taxable and interest payments are deductible, it is the after-tax rate of interest that is relevant for individual constraints and therefore determines behavior.

The theoretical models presented in Chapter III provided testable specifications for household, business, and aggregated demand for money. Three testable hypotheses have also been specified. For the household sector, it was argued that allocation of the total wealth between the means of exchange and interest-bearing assets depends upon the cost of transacting between the two forms of holding wealth and the explicit rate of interest on the interest-bearing notes. However, since the transaction cost in the case of the household sector is not tax deductible, while interest income is, it was argued that the imposition of taxation on interest income reduces the yield of interest-bearing notes while leaving the cost of transactions intact. This, in turn, implies that a change in the tax rate would generate a series of adjustments in the household demand for cash even if the level of transactions and the rate of interest stays constant. Based on this discussion, it was argued that the tax rate does indeed belong in the household demand for money. Accordingly, the null hypothesis was stated as: The tax-adjusted specification is the true model for the household demand for money; while the alternative hypothesis was stated as: The non-tax specification is the true model.

In the case of the business demand for money, it was argued that the cost of transacting between cash and alternative forms of holding assets are tangible costs and, therefore, tax deductible. Consequently, the income tax reduces both the marginal costs and returns of cash economizing by the same proportion and leaves the business demand for money invariant with respect to tax rate. In light of this argument, the null hypothesis was stated as: The non-tax formulation of this demand is the true model.

With respect to the aggregate demand for money, this study used the inventory theoretic model as the point of departure. Based on this model, an increase in the tax rate results in larger cash balances due to the negative substitution effect. While the substitution effect was said to be the direct and obvious effect, another equally important but less obvious force was also identified. This effect, known as the risk-sharing factor, is said to be operating in the opposite direction from the substitution effect. As a result, the final effect of changes in the tax rate on the demand for money is ambiguous. If either effect dominates the other one, then the tax rate does indeed belong in the aggregate demand for money and therefore--as in the case of household demand for money--one expects the tax-adjusted demand for money to be the true model.

The purpose of this chapter is to present the results of the empirical tests of these hypotheses.

Alternative Specification of a Conventional Equation

The standard Goldfeld equation was used for the purpose of model specification. In 1973, this equation became the standard formulation. However, since then forecasts from this equation began to overpredict real money balances. The relatively poor performance of the Goldfeld equation for the post-1973 time period has prompted doubts as to the robustness of this specification. The purpose of this section is to test the Goldfeld equation against some other alternatives, so as to find the best specification. The Goldfeld equation has the following form:

$$\text{Ln } M1 = \text{Ln } c + B_1 \text{ Ln } Y + B_2 \text{ Ln } RTD + B_3 \text{ Ln } RCP + B_4 \text{ Ln } M1(-1)$$

where M1 = real money balances, Y = real GNP, RTD = rate on passbook savings accounts, RCP = rate on three month prime commercial paper, and M1(-1) = M1 lagged one quarter. This specification is tested against the following three alternatives.

$$\text{Ln M1} = \text{Ln c} + B_1 \text{ Ln Y} + B_2 \text{ RTD} + B_3 \text{ RCP} + B_4 \text{ Ln M1}(-1)$$

$$\text{Ln M1} = \text{Ln c} + B_1 \text{ Ln Y} + B_2 \text{ Ln RCP} + B_3 \text{ Ln LTRATE} + B_4 \text{ Ln M1}(-1)$$

$$\text{Ln M1} = \text{Ln c} + B_1 \text{ Ln Y} + B_2 \text{ Ln LTRATE} + B_3 \text{ Ln M1}(-1)$$

where LTRATE = yield on long-term Treasury bonds. The first alternative is the Friedman and Schwartz semi-log equation. This equation has the interest rates themselves rather than their logarithms. The second alternative (ALT2), has both short-term and long-term interest rates. Finally, the third alternative (ALT3) has only one long-term interest rate as the opportunity cost of money. The results of estimating these alternative specifications are reported in Table I.

TABLE I

EMPIRICAL ESTIMATION OF ALTERNATIVE SPECIFICATIONS
1952:2-1980:4

	Equation			
Variable	Goldfeld	Friedman	ALT2	ALT3
Constant	-.161	-.136	-.218*	.0285
Ln Y	.0160	.0385*	.0217	.0662*
Ln RCP	-.0235*	---	-.0241*	---
Ln RTD	.0070	---	---	---
RCP	---	-.0037*	---	---
RTD	---	-.0036	---	---
Ln LTRATE	---	---	.00392	-.0491*
Ln M1(-1)	1.015*	.982*	1.019*	.9247*

TABLE I (Continued)

	Equation			
Variable	Goldfeld	Friedman	ALT2	ALT3
R^2	.979	.977	.975	.952
Standard Error (SE)	.0068	.0068	.0069	.0074
Durbin-Watson (D-W)	2.0193	2.0035	2.0502	2.1868
ρ	.299	.329	.344	.497
Sum of Squared Residuals (SSR)	.00509	.00510	.00516	.0060

*Significantly different from zero at 5-percent level.

As can be seen, all four equations have provided unreasonable estimates. More specifically, the estimated coefficient of lagged M1 turned out to be equal to one. This is an unacceptable speed of adjustment.

As was discuss in Chapter II, there are reasons to believe that the aggregate demand for money has indeed shifted in the 1973-1974 time period. The performance of the Goldfeld equation for the pre-1973 and post-1973 time periods has been most frequently cited as evidence for this suspicion. For the purpose of investigating such an institutional change in the empirical observations of the data and its contribution upon the estimation results, all four equations were estimated for two subsamples, covering 1952:2-1972:4 and 1973:1-1980:4, and a formal Chow test [13][1] was performed. The results are reported in Tables II, III, and IV.

TABLE II

EMPIRICAL ESTIMATION OF ALTERNATIVE SPECIFICATIONS
1952:2-1972:4

	Equation			
Variable	Goldfeld	Friedman	ALT2	ALT3
c	.613*	.331*	.047	.667*
Ln Y	.208*	.221*	.079*	.155*
Ln RCP	-.019*	---	-.020*	---
Ln RTD	-.036*	---	---	---
RCP	---	-.005*	---	---
RTD	---	-.0180*	---	---
Ln LTRATE	---	---	-.009	-.050*
Ln M1(-1)	.637*	.676*	.900*	.695*

[1] An F-test was performed calculating the following ratio:

$$F = \frac{\hat{\Sigma}\, U_t^{*2}/K}{(\Sigma\, \hat{U}_{t1}^2 + \Sigma\, \hat{U}_{t2}^2)/T-2K}$$

where

$$\Sigma\, \hat{U}_t^{*2} = \Sigma\, \hat{U}_t^2 - (\Sigma\, \hat{U}_{t1}^2 + \Sigma\, \hat{U}_{t2}^2) \text{ and,}$$

$\Sigma\, \hat{U}_t^2$ = sum of squared residuals obtained from the entire sample, $\Sigma\, \hat{U}_{t1}^2$ = sum of squared residuals obtained from the 1952:2-1972:4 estimation, and $\Sigma\, \hat{U}_{t2}^2$ = sum of squared residuals obtained from estimating the specified equation for the 1973:1-1979:4 time span. T is to the number of observations and K the number of the independent variables.

TABLE II (Continued)

	Equation			
Variable	Goldfeld	Friedman	ALT2	ALT3
R^2	.978	.982	.987	.944
SE	.0043	.0043	.0046	.0051
D-W	1.8993	1.9597	1.9441	1.8882
ρ	.587	.539	.413	.704
SSR	.00142	.00141	.00167	.00202

*Significantly different from zero at 5-percent level.

TABLE III

EMPIRICAL ESTIMATION OF ALTERNATIVE SPECIFICATIONS
1973:1-1980:4

	Equation			
Variable	Goldfeld	Friedman	ALT2	ALT3
Constant	1.164*	1.102*	-.295	.544
Ln Y	.063*	.063*	.036	.073
Ln RCP	-.0170*	---	-.0291	---
Ln RTD	-.299*	---	---	---
RCP	---	-.002*	---	---
RTD	---	-.066*	---	---
Ln LTRATE	---	---	.0118	-.081*

TABLE III (Continued)

	Equation			
Variable	Goldfeld	Friedman	ALT2	ALT3
Ln M1(-1)	.795*	.773*	1.0126*	.832*
R^2	.983	.985	.971	.967
SE	.0069	.0066	.0092	.0096
D-W	1.9314	1.8991	2.0750	1.9229
ρ	---			
SSR	.0013	.0012	.0023	.0026

*Significantly different from zero at 5-percent level.

Tables II and III reveal that, when divided into two subsamples, three equations provided reasonably good estimates. Only ALT2 reported inferior estimates in all three attempts.

TABLE IV

RESULTS OF CHOW TEST FOR THE ALTERNATIVE SPECIFICATIONS

Equation	Computed Test Statistics	F-Table (DF 5,104)
Goldfeld	18.41	3.17
Friedman	20.32	3.17

TABLE IV (Continued)

Equation	Computed Test Statistics	F-Table (DF 5,104)
ALT1	6.30	3.17
ALT2	6.21	3.17

Table IV shows the results of the Chow test. The comparison of the computed value of _F_ to the value in the _F_ table suggests that the null hypothesis of the equality of the estimated coefficients of the two different subsample structures can be rejected in all four cases. The test therefore rejects the hypothesis that the two sets of regression coefficients are the same and therefore refer to the same structure. Estimating the demand equation for the entire sample period would therefore not be appropriate since the empirical observations of the data do not belong to the same demand curve.

For the present purpose, however, it is not important to investigate why the money demand equation shifted, but rather to find out if it actually shifted. Since the task of finding a demand curve which can be fitted to the entire sample period is an entirely different project and deserves an investigation on its own, this dissertation continues to work with the two subsamples in all of its empirical estimations.

For the purpose of finding the best equation among the four alternatives, the predicted value generated by each was compared with the actual values of _M1_, and a series of error statistics were computed. The results are reported in Table V.

TABLE V

COMPUTED ERROR STATISTICS

	Subsample 1952:2-1972:4		Subsample 1973:1-1980:4	
Equation	RMSE	MAE	RMSE	MAE
Goldfeld	1.305	1.120	1.400	1.143
Friedman	1.379	1.160	1.346	1.111
ALT2	1.299	1.120	1.770	1.716
ALT3	1.306	1.127	1.917	1.386

Based on Table V, it can be seen that two of the equations, the Goldfeld and Friedman specifications, generate the smallest error statistics. The Goldfeld specification yields better statistics for the first subperiod, while the semi-log equation is marginally superior in the second subperiod. One major drawback of the semi-log equation is its unusually low estimates of interest rate elasticity. For example, the long-run elasticity of the demand for money with respect to RCP is .02 for the first subsamples. This is a rather low estimate, given the results of the previous empirical work.

Given that the semi-log equation has at best marginally better statistics for the 1973:1-1980:4 time period and also the fact that it generated unusually low elasticity estimates, this dissertation uses the Goldfeld specification as the best among the four alternatives. This implies that the models as formulated in Chapter III are therefore properly specified.

Empirical Estimation

Aggregate Demand for Money

The proposed specifications of the aggregated demand for money are fitted to the empirical observation of the data, and the results are presented in Table VI.

As can be recalled, the aggregate demand for money has the following formulation:

$$\text{Ln } M1 = \text{Ln } \alpha + B_1 \text{ Ln } Y + B_2 \text{ Ln } RCP + B_3 \text{ Ln } RTD + B_4 \text{ Ln } M1(-1)$$

where M1 = real money balances, Y = real GNP, RCP = rate on six month commercial paper, RTD = rate on passbook savings deposits and M1(-1) = M1 lagged one quarter.

As can be seen, both versions of the aggregated demand for money have reasonable parameter values. In addition, each fits the data quite well. At first glance, the comparison of the adjusted R-square and the standard error of the two equations point toward marginal superiority of the non-tax specification. However, the conclusion of true superiority of this specification against the tax-adjusted specification must wait pending additional tests.

According to the econometric discussion in Chapter IV, it was expected that the tax-adjusted specification to report different income and interest elasticities. The direction of changes was said to be ambiguous, depending upon which of the two opposing forces, substitution or the risk-sharing effect, prevails. By and large, the short-run elasticities estimated from the tax-adjusted equation do not render the expected results. This point can be shown by setting up an F-test to test the following hypotheses:

TABLE VI

ESTIMATES OF THE TWO VERSIONS OF THE AGGREGATED DEMAND FOR MONEY 1952:2-1972:4

Variables	Estimated Coefficients	
	Non-Tax Specification	Tax-Adjusted Specification[2]
Constant	.613* (2.92)	.532* (2.45)
Ln Y	.208* (6.03)	.207* (5.87)
Ln RCP	-.0192* (-5.3)	-.0198* (-5.18)
Ln RTD	-.0361* (-4.03)	-.0334* (-3.70)
Ln M1(-1)	.637* (8.48)	.650* (8.56)
R^2	.977	.971
Standard Error of the Regression	.0043	.0044
Durbin-Watson	1.8993	1.9369
Rho	.587	.626
Long-Run Elasticities		
M1, Y	.57	.59
M1, RCP	.053	.057
M1, RTD	.10	.095

[2]This equation is adjusted for the tax rate using Seater estimates of the marginal tax-rate. Barro and Sahasakul (B-S) [3] have estimated a different series for this tax-rate. When the Goldfeld equation was adjusted using <u>B-S</u> marginal tax-rate estimates, and the equation was fitted to the data, the results were:

TABLE VI (Continued)

$$\text{Ln M1} = .563 + .196 \text{ Ln Y} - .0197 \text{ Ln RCP}^T$$
$$(2.55) \quad (5.75) \qquad (-5.12)$$

$$- .0306 \text{ Ln RTD}^T + .653 \text{ Ln M1}(-1)$$
$$(-3.50) \qquad (8.57)$$

$R^2 = .97$ Std. Error = .0044 D-W = 1.9327 Rho = .628

It is clear that this result is almost identical to the tax-adjusted specification using the Seater's tax-series.

For a complete discussion on how each series is estimated, the interested reader should see Appendix A.

*Statistically significant at 5 percent level.

The numbers in parentheses correspond to the t-statistics.

$$H_0: \quad B_i - B_i^T = 0$$

$$H_1: \quad B_i - B_i^T \neq 0$$

where the null hypothesis states that the elasticities estimated from the two specifications are the same. This test was conducted using the following procedure. Assume the following two regression models:

$$Y = X\,B + U$$

$$Y = X^*\,B^* + U^*$$

where X and X* are N x K matrices of independent variable observations for the gross and net money demand equations, respectively. The null hypothesis is: $B - B^* = 0$. This can be tested by estimating the following two regression models:

$$\begin{bmatrix} Y \\ \hline Y \end{bmatrix} = \begin{bmatrix} X & 0 \\ \hline X^* & X^* \end{bmatrix} \begin{bmatrix} B \\ \hline B^*-B \end{bmatrix} = \begin{bmatrix} XB \\ \hline X^*B+X^*(B^*-B) \end{bmatrix}$$

and

$$\begin{bmatrix} Y \\ \hline Y \end{bmatrix} = \begin{bmatrix} X \\ \hline X^* \end{bmatrix} B = \begin{bmatrix} XB \\ \hline X^*B \end{bmatrix}$$

For the sake of simplicity, the first regression is called the unrestricted model (UR) and the second the restricted model (R). The null hypothesis can be tested by computing the following test statistics:

$$F_{STAT} = \frac{(ESS_R - ESS_{UR})/K}{ESS_{UR}/2(N-K)}$$

where ESS_R and ESS_{UR} represent the error sum of squares for the restricted and unrestricted models.

F_{STAT} is computed for the estimated equations and is equal to .108. The comparison of this calculated value of F to the value in the F table, 2.21 (dF 5, 155), suggests that the null hypothesis of the equality of the estimated coefficients of the two regression models cannot be rejected at the five percent level. Therefore, with respect to the coefficients in Table VI, the null hypothesis of H_0: $B_i - B_i^T = 0$ cannot be rejected.

One possible explanation for these results may have to do with the fact that the nominal and net of taxes rates of interest are highly correlated. The correlation coefficient estimated for these two variables is .98. This, of course, can be attributed to the rather stable marginal tax rate measures over the entire sample period.

Yet another explanation may have to do with the possibility of no causal relationship between the demand for money and the tax rate. If this is the case, the estimated coefficient for the tax rate would be zero, and therefore the elasticity estimates of the conventional specification yields an unbiased estimate of the true elasticity. However, this analysis depends crucially on the fact that the specification tests reject the notion of tax-adjusted specification as the true model for explaining the aggregated demand for money. It is, however, obvious that this conclusion cannot be firmly drawn until all specification tests are completed.

The two versions of the aggregate demand for money are also fitted to the empirical observations of the data covering subsample 1973:1-1980:1. The results are reported in Table VII.

Again, no substantial differences can be observed in the estimated coefficients of the two versions. The two equations report almost identical coefficients with respect to the income and interest rate variables.

Household Demand for Money

The two versions of the household demand for money were fitted to the empirical observations of the data and the estimated results are presented in Table VIII.

The household demand for money has the following specification:

$$\text{Ln M1H} = \text{Ln } \alpha + B_1 \text{ Ln CONS} + B_2 \text{ Ln RCP} + B_3 \text{ Ln RTD} + B_4 \text{ Ln M1H}(-1)$$

where M1H = household real money balances, CONS = real consumption expenditures, and M1H(-1) = M1H lagged one quarter.

Table VIII indicates that, similar to the case for the aggregated demand for money, the non-tax adjusted specification for household sector appears to be marginally superior to that of the tax-adjusted specification, as can be seen by comparing the coefficient of determination and the standard error of the two regressions.

TABLE VII

ESTIMATES OF THE TWO VERSIONS OF THE AGGREGATED DEMAND FOR MONEY 1973:1-1980:4

Variables	Estimated Coefficients			
	Non-Tax Specification		Tax-Adjusted Specification[3]	
Constant	1.16	(2.73)	.761	(1.91)
Ln Y	.062	(2.57)	.064	(2.50)
Ln RCP	-.017	(-3.49)	-.016	(-3.14)
Ln RTD	-.298	(-4.63)	-.276	(-4.24)
Ln M1(-1)	.795	(14.99)	.845	(17.51)
R^2	.98		.98	
Stand. Error of Regression	.0068		.0071	
D-W	1.9314		1.9098	
h =	.203		.265	

[3]The conventional formulation, when adjusted for the tax rate using B-S tax-estimates, reported the following results

$$\underset{}{\text{Ln M1}} = \underset{(1.75)}{.775} + \underset{(.85)}{.022}\ \text{Ln Y} - \underset{(-2.14)}{.013}\ \text{Ln RCP}$$

$$- \underset{(-3.54)}{.226}\ \text{Ln RTD} + \underset{(18.27)}{.879}\ \text{Ln M1(-1)}$$

TABLE VII (Continued)

$R^2 = .98$ D-W = 1.9269 Std. Error = .0076 h = .215

The estimated models report unreasonably low income elasticities (.18). In addition, this equation reports the highest standard error amongst the three alternatives. The interest rate elasticity, both short and long run, is however close.

The numbers in parentheses correspond to the t-statistics.

Also, similar to the aggregated demand for money, the null hypothesis of the equality of the point estimates of the coefficients of the two regressions cannot be rejected for the scale and interest rate variables in the household demand for money. For testing this hypothesis, the test-statistics described for the aggregated demand for money were computed. It turned out that the F_{STAT} is equal to 0.114, which when compared with that of the table, (2.21, dF 5, 155), suggests that the null hypothesis, H_0: $B_i - B_i^T = 0$ cannot be rejected at the 5 percent level. This, in turn, implies although the inclusion of the tax-variable in the household demand for money did in general result in a lower elasticity of this demand with respect to income and the rate on time deposits, though the difference is not statistically significant.

As was discussed in Chapter III, given the relatively low cost of adjustment in the case of the household sector, one would expect that the speed of adjustment would be much faster for households than for the aggregated equation. This is borne out by the household speed of adjustment. In general, it can be seen that the household sector acts twice as fast as the aggregated economy to adjust for any discrepancy between the optimal and the actual money balances. The difference between the case of the household and the aggregated versions is, of course, a result of a very slow speed of adjustment for the business sector. The coefficient of the lagged dependent variable in the business demand for money would be evidence of the truth of this argument.

TABLE VIII

RESULTS OF THE EMPIRICAL ESTIMATION FOR THE HOUSEHOLD DEMAND FOR MONEY 1952:2-1972:4

Variables	Estimated Coefficients	
	Non-Tax Specification	Tax-Adjusted Specification[4]
Constant	-.642 (-2.28)*	-.529 (-1.71)
Ln CONS	.703 (7.43)*	.667 (6.97)*
Ln RCP	-.0134 (-1.19)	-.0143 (-1.20)
Ln RTD	-.156 (-5.33)*	-.139 (-4.66)*
Ln M1(-1)	.232 (2.29)*	.242 (2.33)*
R^2	.9000	.8700
Standard Error of Regression	.0133	.0138
Durbin-Watson	2.0423	2.0812
Rho	.652	.634

TABLE VIII (Continued)

Variables	Estimated Coefficients	
	Non-Tax Specification	Tax-Adjusted Specification
Long-Run Elasticities		
M1H, CONS	.92	.89
M1H, RCP	.017	.019
M1H, RTD	.203	.183

[4]Tax-Adjusted Specification, using B-S tax series:

$$\text{Ln M1H} = -.568 + .684 \text{ Ln CONS} - .0139 \text{ Ln RCPT}$$
$$(-1.86) \quad (7.14) \qquad (-1.18)$$

$$- .145 \text{ Ln RTDT} + .233 \text{ Ln M1}(-1)$$
$$(-4.86) \qquad (2.26)$$

$R^2 = .879$ Std. Error = .0136 D-W = 2.0665 Rho = .681

*Significantly different from zero at 5 percent level.

The numbers in the parentheses correspond to the t-statistics.

Another striking difference between the household and the aggregated demand for money can be seen when one compares the short-run and long-run elasticities of the demand for money with respect to the scale variable and the rate on time deposits. The comparison of the estimated elasticities reveals that the elasticities are much larger for the households than they are for the aggregated economy. This is what Hamburger [39] found.

Table IX reports the estimated coefficients of the regression model for the 1973:1-1980:4 subsample:

TABLE IX

EMPIRICAL ESTIMATES OF THE HOUSEHOLD DEMAND FOR MONEY 1973:1-1980:4

Variables	Estimated Coefficients	
	Non-Tax Specification	Tax-Adjusted Specification[5]
Constant	1.16 (1.94)	1.19 (1.99)
Ln CONS	.166 (2.29)	.148 (2.20)
Ln RCP	-.028 (-2.26)	-.029 (-2.33)
Ln RTD	-.449 (-3.11)	-.478 (-3.21)
Ln M1H(-1)	.690 (6.53)	.700 (6.82)
R^2	.81	.82
Std. Error	.0198	.0196
D-W	1.7881	1.7972
h	.74	.70

[5]Tax-Adjusted Specification, adjusted by B-S estimates:

$$\text{Ln M1H} = \underset{(2.76)}{1.88} - \underset{(-.002)}{.00008}\ \text{Ln CONS} - \underset{(-2.26)}{.028}\ \text{Ln RCP}^T$$

$$- \underset{(-3.10)}{.421}\ \text{Ln RTD}^T + \underset{(7.37)}{.732}\ \text{Ln M1H}(-1)$$

$R^2 = .81$ Std. Error = .0197 D-W = 1.8252 h = .72

TABLE IX (Continued)

This equation provides identical interest rate elasticity, but substantially different income elasticity. This estimate on CONS is unreasonably low and carries the wrong sign.

Yet, again, as in the case of the aggregated demand for money, the tax-adjusted specification of the household demand for money failed to generate the expected results with respect to the elasticity issue. Although in general the tax-adjusted equation did report lower elasticities than the non-tax equation, nonetheless the null hypothesis of the corresponding two coefficients--derived from the two specifications' being equal--were not rejected, making the two estimates of elasticities statistically the same. One explanation for this apparent failure of the tax-adjusted equation may have to do with the possibility that the empirical data may not support the theoretical work on the point that the tax-variable belongs in the household demand for money. Although a clear possibility, the final verdict on this must wait pending completion of the specification tests.

Business Demand for Money

The proposed specifications of the business demand for money were fitted to the empirical observations of the data, and the results are presented in Table X.

The business demand for money has the following formulation:

$$\text{Ln } M1B = \text{Ln } \alpha + B_1 \text{ Ln } SALE + B_2 \text{ Ln } RCP + B_3 \text{ Ln } M1B(-1)$$

where M1B = business real holdings of cash balances, SALE = manufacturing and trade real sales, and M1B(-1) = M1B lagged one quarter.

TABLE X

EMPIRICAL ESTIMATION OF THE TWO VERSIONS OF THE BUSINESS DEMAND FOR MONEY 1952:2-1972:4

	Estimated Coefficients	
Variables	Non-Tax Specification	Tax-Adjusted Specification[6]
Constant	.583 (2.04)	.548 (1.91)
Ln SALE	.0437 (2.89)	.0491 (3.05)
Ln RCP	-.0195 (-2.47)	-.0212 (-2.65)
Ln M1B(-1)	.819 (12.33)	.818 (12.41)
R^2	.8163	.8155
Standard Error of the Regression	.016	.016
Durbin-Watson	1.9416	1.9571
Durbin-h	.240	.244

The numbers in parentheses correspond to the t-statistics.

[6]Business money demand adjusted for tax-rate using <u>B-S</u> series:

TABLE X (Continued)

$$\text{Ln M1B} = \underset{(1.93)}{.551} + \underset{(3.07)}{.0484}\ \text{Ln SALE} - \underset{(-2.66)}{.0212}\ \text{Ln RCP}^{T}$$

$$+ \underset{(12.42)}{.818}\ \text{Ln M1B}(-1)$$

$R^2 = .80$ D-W = 1.9583   Std. Error = .016   h = .236

As can be recalled from Chapter III, in the case of business demand for money, both the cost and return from cash economizing are money costs and therefore tax-deductible. Consequently, since the tax-rate reduces the marginal cost and return by the same proportion, the business demand for money is invariant with respect to the tax-rate; the non-tax specification should therefore be the true model to represent the firms' demand for money.

In light of this argument, it is obvious that one should not expect the elasticity of the business demand for money with respect to the transactions variable and the rate of interest, estimated from the two proposed specifications, to be statistically different. To test this proposition, an F-test identical to the one described for the aggregated demand for money was set up to test the following hypotheses:

$$H_0: \quad B_i - B_i^T = 0$$

$$H_1: \quad B_i - B_i^T \neq 0$$

where the null hypothesis states that the corresponding elasticities of the two specifications are statistically different, while the alternative hypothesis is that they are statistically equal.

The results of the tests clearly indicated that the null hypothesis can be rejected for both the scale and the interest variable, therefore implying that the two sets of estimates derived from the two regressions are statistically the same. That is, of course, consistent with the view that the tax variable does not belong in the business demand for money and the elasticity of this sector's demand for money with respect to the transaction and the rate of interest variable, estimated from the non-tax specification, are the unbiased estimates.

A close examination of the estimated coefficients of the lagged dependent variable in Table III reveals that the business sector's responsiveness to changes in the short-term rate of interest appears to be very sluggish. This is consistent with the analysis presented in Chapter III. It was postulated that corporations, faced with large overhead expenses, will become more and more actively engaged in cash economizing techniques if they are convinced that the trend in interest rates is going to persist for a long period.

The proposed specification for the business money demand equation is also fitted to the empirical observation of the data covering the subsample 1973:1-1980:4 and the results are shown in Table XI.

When estimated over the 1973:1-1980:4 time span, the specification completely breaks down. It reports unreasonably slow speeds of adjustment. In addition, the estimated income and interest elasticities are not significantly different from zero. The former also has the wrong sign. The results of the tax-adjusted equation are identical to the non-tax format, thus the tax-adjusted equation does not provide any improvements. When Seater's tax-series are replaced by the <u>B-S</u> series, the results are identical.

TABLE XI

ESTIMATES OF THE TWO VERSIONS OF THE BUSINESS DEMAND FOR MONEY 1973:1-1980:4

Variables	Non-Tax Specification		Tax-Adjusted Specification[7]	
Constant	.250	(.98)	.249	(1.00
Ln SALE	-.001	(-.43)	-.001	(-.43)
Ln RCP	-.011	(-.70)	-.011	(-.74)
Ln M1B(-1)	.946	(16.48)	.945	(16.52)
R^2	.94		.94	
Std. Error	.0233		.0233	
D-W	2.3476		2.3473	
h-statistics	-1.04		-1.03	

[7]Business money demand adjusted for tax-rate using B-S series:

$$\text{Ln M1B} = \underset{(.98)}{.241} - \underset{(-.44)}{.001} \text{ Ln SALE} - \underset{(-.76)}{.011} \text{ Ln RCP}^{T} + \underset{(16.73)}{.947} \text{ M1B}(-1)$$

$R^2 = .94$ D-W = 2.3478 Std. Error = .0231 h = -1.02

This result implies the observed instability in the aggregate demand for money may be largely due to the erratic behavior of the business demand equation.

Tax Rate and the Demand for Money: Substitution and Risk-Sharing Effects

As was discussed, changes in the tax rate have two major effects on the demand for money--(a) the substitution effect, and (b) the risk-sharing effect. The purpose of this section is to identify the dominant effect.

In the inventory theoretic model, the tax rate enters the demand for money through its effect on the opportunity cost of holding money. Using the inventory model as the point of departure, the following equation is specified:

$$\text{Ln M1} = B_0 + B_1 \text{ Ln RCP}(1-t) + B_2 \text{ Ln RTD}(1-t) + B_3 \text{ Ln Y} + B_4 \text{ Ln M1}(-1)$$

This equation explicitly accounts only for the substitution effect since the opportunity cost is represented by the net interest rate rather than the nominal rate. In order to consider the risk-sharing effect in this equation, it is adjusted to give:

$$\text{Ln M1} = B_0 + B_1 \text{ Ln RCP}(1-t) + B_2 \text{ Ln RTD}(1-t) + B_3 \text{ Ln Y} + B_4 \text{ Ln M1}(-1) + B_5 \text{ Ln }(1-t)$$

In this context, the terms <u>RCP(1-t)</u> and <u>RTD(1-t)</u> capture the substitution adjustments and the term Ln (1-t) picks up any residual effect which is not picked up in the net interest rates or the risk-sharing adjustment. In order to identify the dominant effect, this equation can be expanded to give:

(A) $$\text{Ln M1} = B_0 + B_1 \text{ Ln RCP} + B_2 \text{ Ln RTD} + B_3 \text{ Ln Y} + B_4 \text{ Ln M1}(-1) + B_5^* \text{ Ln }(1-t)$$

where $B_5^* = B_5 + B_1 + B_2$.

Based on D-M's analysis $B_5 > 0$, because $\frac{\partial \text{ Ln M1}}{\partial t} < 0$ or $\frac{\partial \text{ Ln M1}}{\partial (1-t)} > 0$. The empirical results indicate that B_1 and B_2 are negative, which implies that $B_5^* \lesseqgtr 0$, as $B_5 \lesseqgtr B_1 + B_2$. In other words:

1. If $B_5^* > 0$, the risk-sharing effect outweighs the substitution effect.
2. If $B_5^* < 0$, the substitution effect is the dominant factor.
3. If $B_5^* = 0$, the two effects cancel each other.

This testing procedure is applied to the aggregate and household demand for money, and the results are reported in Table XII.[8]

The results indicate that, in the cases of the aggregate and business sectors, the two opposing forces just offset each other. However, in the case of the household sector, the risk-sharing factor is

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[8]The reported regression models for the aggregate, household and business demand for money are:

$$\underset{}{\text{Ln M1}} = \underset{(2.83)}{.640} + \underset{(5.94)}{.203}\text{ Ln Y} - \underset{(-5.07)}{.0187}\text{ Ln RCP} - \underset{(-3.98)}{.0359}\text{ Ln RTD}$$

$$+ \underset{(8.37)}{.639}\text{ Ln M1(-1)} + \underset{(.60)}{.0242}\text{ Ln (1-t)}$$

$R^2 = .98$ D-W = 1.8869 Std. Error = .0043 Rho = .565

$$\text{Ln M1H} = \underset{(-.73)}{-.205} + \underset{(7.21)}{.642}\text{ Ln CONS} - \underset{(-.57)}{.006}\text{ Ln RCP} - \underset{(-5.93)}{.158}\text{ Ln RTD}$$

$$+ \underset{(2.52)}{.243}\text{ Ln M1H(-1)} + \underset{(3.06)}{.367}\text{ Ln (1-t)}$$

$R^2 = .93$ D-W = 2.0063 Std. Error = .0127 = .0127 Rho = .595

$$\text{Ln M1B} = \underset{(1.50)}{.438} + \underset{(3.42)}{.0689}\text{ Ln SALE} - \underset{(-2.85)}{.0227}\text{ Ln RCP}$$

$$+ \underset{(12.35)}{.810}\text{ Ln M1B(-1)} - \underset{(-1.85)}{.150}\text{ Ln (1-t)}$$

the dominant factor. As a result, as the tax rate increases, household demand for money declines.

TABLE XII

THE ESTIMATED B_5^* COEFFICIENTS FOR THE THREE DEMAND FOR MONEY EQUATIONS 1952:4-1972:4

Equation	Estimated B_5^*	t-statistics
Aggregate Demand for Money*	.024	.60
Household Demand for Money*	.367	3.06
Business Demand for Money	-.150	-1.85

*Equation was corrected for first-order correlation.

The described test was conducted to cover the 1973:1-1980:4 subperiod. The results are reported in Table XIII.

As Table XIII indicates, the two opposing effectx offset each other, leaving demand for money invariant to the changes in tax rate in all three cases.

Testing Hypotheses

Household Demand for Money

The theoretical work indicates that the net interest rate belong in the household demand for money. In this section, the Davidson and

MacKinnon and Pesaran-Deaton, specification tests are used to investigate whether this proposition is supported by the data.

TABLE XIII

THE ESTIMATED B_5^* COEFFICIENTS FOR THE THREE DEMAND FOR MONEY EQUATIONS 1973:1-1980:4

Equation	Estimated B_5^*	t-statistics
Aggregate Demand for Money	-.032	-.17
Household Demand for Money	-.123	-.83
Business Demand for Money	-1.01	-1.73

As was stated in Chapter IV, the hypotheses are stated as follows:

H_0 = the tax-adjusted specification is the true model.

H_1 = the non-tax specification is the true model.

The null hypothesis simply states that the conventional approach, namely, the non-tax specification, is the true model to represent the household demand for money. The alternative hypothesis is stated as: The tax-adjusted specification is the true model for representing this sector's demand for cash balances.

The hypotheses can be tested by simply looking at the relative performance of the two specifications in terms of the standard error of the regression and the residual sum of squares. On this criterion,

Table XV reveals that the non-tax specification is marginally superior to the tax-adjusted specification.

Alternatively, one can also compare the predicted values of each specification with the actual values of the dependent variables and compute a series of error statistics. Or, one can reestimate the two equations over a shortened period and then compare their relative forecasting abilities over the remainder of the sample period. Tables XIV and XV show the results of applying these two simple testing procedures to the proposed specifications of the household demand for money.

As Table XIV indicates, the tax-adjusted specification gives slightly lower error statistics. A further test of the relative performance of the two specifications is also provided in Table XV.

TABLE XIV

COMPARISON OF THE ACTUAL AND PREDICTED SERIES AT THE HOUSEHOLD DEMAND FOR MONEY (1952:2-1972:4)

Equation	RMSE	MAE
Non-Tax Specification	.00968	.0080
Tax-Adjusted Specification	.00931	.0077

RMSE = Root-Mean-Square-Error.

MAE = Mean-Absolute-Error.

TABLE XV

ERROR STATISTICS OF 1966:1-1972:4 FORECASTS
FOR THE HOUSEHOLD DEMAND FOR MONEY

Equation	RMSE	MAE
Non-Tax Specification	.0113	.0099
Tax-Adjusted Specification	.0111	.0095

The household demand for money, in both versions, was reestimated for the time-period 1952:2-1965:4, and then the remainder of the sample period was forecasted based on this reestimated equation. As Table XV indicates, the tax-adjusted specification performed marginally better in forecasting the 1966:1-1972:4 values of household demand for money.

Davidson and MacKinnon's specification test allows a test of a model against a non-nested alternative. The predicted values of the dependent variable from the alternative specification are used as an independent argument in the equation which is believed to be the true model. If the estimated coefficient for this variable, α, is not statistically different from zero, the null hypothesis of the equation's being the true model cannot be rejected. If the coefficient is significantly greater than zero, then the null hypothesis is rejected. Since the results of the test crucially depend upon the magnitude of a single coefficient, a high degree of multicollinearity among the independent variables distorts the accuracy of the test. In order to deal with this situation, the test was applied using both the level, and the first difference of the data. Plosser and Schwert [64] argue that, by using the first differences the time trend is eliminated and the high frequency component of the data is emphasized. Consequently the multi-collinearity problem is reduced.[10] Table XVI represents the results of the Davidson-MacKinnon specification test for the household demand for money.

TABLE XVI

RESULTS OF DAVIDSON-MacKINNON SPECIFICATION TEST (1952:2-1972:4)

Level of the Data	α	t-test
Non-Tax Specification	.340	1.070
Tax-Adjusted Specification	1.229	4.140*
First Difference of the Data		
Non-Tax Specification	-3.227	-1.755
Tax-Adjusted Specification	3.402	2.391*

*Significant at 5 percent level.

α = the coefficient for the predicted series of M1H from the alternative specification.

[10] Hamburger [39] used the first difference of the data for apparently the same reason.

With the non-tax specification hypothesized as the true model the Davidson-MaKinnon test indicates that the null hypothesis (that the non-tax specification is the true model) cannot be rejected; the non-tax specification is not significantly different. In order to test the tax-adjusted specification against the alternative model, the testing procedure is reversed. In this case, the null hypothesis is that the tax-adjusted specification is the true model and the predicted values of the non-tax specification become observations on the independent variable in the former equation. The Davidson-MacKinnon specification test, using the level of the data, reject the null hypothesis that the tax-adjusted equation is the true model for representing the household demand for money; the t-ratio associated with the α coefficient for the tax-adjusted equation is significant at the one percent level. Tests using the first differences of the data render the same conclusion, namely, the null hypothesis that the non-tax specification is the true model was not rejected, while the hypothesis that the tax-adjusted specification being the true specification was rejected at the five percent significance level.

The two versions of the household demand for money were tested against each other by using the Pesaran and Deaton (P-D) test. The results are shown in Table XVII.

The P-D specification test confirms the D-M test results. Namely, the null hypothesis that the non-tax specification is the true model cannot be rejected, while the null hypothesis that the tax-adjusted equation is the true model is rejected at the one percent level.

The results of the specification tests are startling at first glance. By and large, based on the theoretical work, one would expect that the tax-adjusted specification would be superior to the non-tax equation. However, the empirical data do not support this view. Both specification tests reject the tax-adjusted equation, while neither rejects the conventional formulation. This implies that despite the theoretical prediction, it is the non-tax specification which is the true model in the case of the household demand for money.

TABLE XVII

RESULTS OF PESARAN AND DEATON SPECIFICATION TEST

Equation	T	V(T)	N-Ratio
Non-Tax Specification	-4.28	11.256	-1.28
Tax-Adjusted Specification	-8.60	7.34	-3.17*

*Significant at 5 percent level.

However, this result is in agreement with the previous empirical work on the topic. As can be recalled from Chapter II, Butters [11] surveyed a nonrandom sample of 749 investors and asked how the 1944 tax changes influenced their portfolio. Almost 70 percent responded that it had no influence on their investment decisions. In a study by the University of Michigan [2], Butters' conclusion was confirmed. They concluded that only a small percentage of the population under study was actually aware of the changes in the tax law and took that into consideration. Given these limited surveys and the results of the specification tests by this study, the conclusion can be stated as: The relevant opportunity cost of holding money for the household seems to be the nominal rate of interest and not the rate net of taxes.

Business Demand for Money

As has been discussed throughout this study, the theoretical work points out that the tax variable is irrelevant to the business demand for money. In this context, the null hypothesis for the business sector can be stated as: The non tax-adjusted specification is superior to the conventional formulation and therefore represents the true model, while the alternative hypothesis can be stated as: The two models are basically the same with regard to explaining the behavior of the business sector.

The stated hypotheses for the business sector were tested by comparing the relative performance of the two specifications in predicting the actual data series and by comparing the forecasting ability of the two equations. The results of these basic tests are reported in Tables XVIII and XIX. Tables XVIII and XIX indicate that the tax-adjusted equation has a slight edge over the alternative specification.

In the search for the correct specification, the two alternative formulations are tested against each other using both the Davidson-MacKinnon and the Pesaran-Deaton specification tests. The results are reported in Tables XX and XXI.

As can be seen from Tables XX and XXI, both tests indicated that neither specification can be rejected when tested against the alternative equation. In a sense, one cannot reject the hypothesis that, in explaining the business sector money demand functions, the two specifications are on equal footing. This conclusion, of course, agrees with the *a priori* expectation that the business demand for money stays invariant with respect to the tax-variable, and no gain can be expected from including the tax variable in the argument of this sector's demand for money.

TABLE XVIII

COMPARISON OF ACTUAL AND PREDICTED SERIES OF THE BUSINESS DEMAND FOR MONEY EQUATIONS 1952:2-1972:4

Equation	RMSE	MAE
Non-Tax Specification	.0156	.00935
Tax-Adjusted Specification	.0156	.00944

TABLE XIX

ERROR STATISTICS OF 1966-1972 FORECAST FOR BUSINESS DEMAND FOR MONEY

Equation	RMSE	MAE
Non-Tax Specification	.0198	.0115
Tax-Adjusted Specification	.0191	.0102

TABLE XX

RESULTS OF DAVIDSON-MacKINNON SPECIFICATION TEST FOR BUSINESS DEMAND FOR MONEY

Using the Level of the Data	α	t-stat
Non-Tax Specification	7.0764	1.8554
Tax-Adjusted Specification	-6.05167	-1.6004

TABLE XXI

RESULTS OF PESARAN-DEATON SPECIFICATION TEST FOR BUSINESS DEMAND FOR MONEY

Equation	T	V(T)	N-Ratio
Non-Tax Specification	-.216	.0137	-1.85
Tax-Adjusted Specification	.21	.0158	1.67

Aggregated Demand for Money

The same testing procedures were applied to the aggregated demand for money specifications. First, the equations were estimated over the entire sample, and the predicted and actual values were compared and the error statistics were computed. Next, the two specifications were estimated over the 1952:2-1965:4 time period and the remainder of the sample observation was forecasted based on these estimations. The results of these tests are shown in Tables XXII and XXIII.

TABLE XXII

COMPARISON OF THE ACTUAL AND PREDICTED SERIES OF THE TWO SPECIFICATIONS FOR THE AGGREGATED DEMAND FOR MONEY (SAMPLE PERIOD 1952:2-1972:4)

Equation	RMSE	MAE
Non-Tax Specification	.00603	.00523
Tax-Adjusted Specification	.00604	.00531

As can be seen from Tables XXII and XXIII, in both criteria the two specifications give almost the same error statistics. This implies that neither specification can be preferred to the other based on these results.

In order to see which specification is representing the true model, the Pesaran-Deaton and Davidson-MacKinnon specification tests were applied, and results are reported in Tables XXIV and XXV.

The results of the Davidson-MacKinnon specification test depend upon the t-values of the α-coefficient. If α is significantly greater than zero, then the null hypothesis that the corresponding equation is the true model is rejected. If, however, α is not statistically different from zero, then the null hypothesis cannot be rejected. As is clear from Table XVI, the Davidson-MacKinnon specification test implies that neither specification can be rejected. In other words, the two alternatives are equally capable of explaining the movements of the aggregate demand for money.

TABLE XXIII

ERROR STATISTICS FOR 1966-1972 FORECASTS FOR THE AGGREGATED DEMAND FOR MONEY

Equation	RMSE	MAE
Non-Tax Specification	.0157	.0149
Tax-Adjusted Specification	.0159	.0150

TABLE XXIV

RESULTS OF DAVIDSON-MacKINNON SPECIFICATION TEST FOR THE AGGREGATE DEMAND FOR MONEY (1952:2-1972:4)

	α	t-stat
Non-Tax Specification	-.129	-.132
Tax-Adjusted Specification	1.111	1.232

In order to complete the testing procedure, the the two specifications were tested against each other, using the P-D specification test. The results are reported in Table XXV.

As was stated, the P-D specification test is based on the magnitude of the N-ratio. At the five percent level, if this test statistic is less than 1.96, then we cannot reject the hypothesis that the corresponding specification represents the true model. However, if the

N-ratio is larger than 1.96, then the hypothesis can be rejected at the 5 percent level of significance.

TABLE XXV

RESULTS OF PESARAN-DEATON SPECIFICATION TEST FOR THE AGGREGATED DEMAND FOR MONEY (1952:2-1972:4)

	T	V(T)	N-Ratio
Non-Tax Specification	-2.29	13.90	-.61
Tax-Adjusted Specification	-3.95	14.42	-1.04

Table XXV indicates that neither specification can be rejected. This implies that no distinction can be made as to which specification is the true model. In a sense, the result can be interpreted as the two equations are basically the same and there is nothing to be gained by treating the tax variable as one of the arguments in the demand for money function.

Although both specification tests reject the theoretical prediction that the conventional work on the topic has misspecified the demand for money, the results should not be taken as unexpected. The aggregated demand for money is composed of the demand for money by the following sectors: household, business, state and local government, financial sectors, and the rest of the world. However, historically, about 90 percent of the total money in the economy has been held by the household and business sectors. This implies that, for all practical purposes, one can reasonably assume that the aggregated demand for money is composed of the household and business demand for money. Working within this framework, it is clear that the theory suggests that the tax rate is only relevant to the household demand equation, while business demand for money is said to be invariant with respect to the tax variable. Therefore, for demand for money to be a function of the tax rate as well as other variables, it is necessary, but not sufficient, that the tax rate be a valid argument in the household demand for money. However, the data clearly rejected the tax-adjusted specification as the true model for the household sector. Given the result for the household sector, one expects that the specification test should not result in the superiority of the tax-adjusted specification in the case of aggregated demand for money; and that is what the results indicate.

Tax Rate and the Demand for Money: An Alternative Test

A closer examination of the empirical observations of the data reveals that in the first quarters of 1964 and 1968 there was a substantial change in tax laws in the first quarter of 1964 and the third quarter of 1968. For example, in 1964 the personal marginal tax was reduced from 17.4 percent to 14.6 percent. In the same year, corporate marginal taxes were reduced from 52 to 50 percent. In the third quarter of 1968, the economy experienced a change in the opposite direction. The marginal individual income tax rate was increased from 14.9 to 17.3 percent while the corporate marginal tax was increased from 48 to 52.8 percent. For both periods, nominal interest rates stayed relatively constant, e.g., RCP increased from 3.91 to 3.95 percent in

1964 and stayed constant at 5.96 percent throughout the 1968:3-1968:4 time period.

Given this fact, the issue of which equation is the true model can be addressed by estimating the two alternative specifications over the subsample 1952:2-1972:4, while treating 1964:1 and 1968:3 as outliers. The estimated equation then can be used to forecast the total money holdings for these two periods. The comparison of the predicted and actual values in this case can be used to compare the relative performance of the two alternative specifications. If the tax-adjusted specification is the true model, then it should give smaller error statistics. The results of this test are presented in Table XXVI.

TABLE XXVI

COMPARISON OF THE ACTUAL AND PREDICTED SERIES FOR 1964:1 AND 1968:1

	RMSE	MAE
Aggregate Demand for Money		
Non-Tax Specification	.4668	.4367
Tax-Adjusted Specification*	.2888	.2834
Household Demand for Money		
Non-Tax Specification	.4650	.4322
Tax-Adjusted Specification*	.9874	.9809
Business Demand for Money		
Non-Tax Specification	1.670	1.305
Tax-Adjusted Specification*	1.641	1.267

TABLE XXVI (Continued)

*Adjusted using Seater's tax-series

In the case of the household sector, the tax-adjusted specification is found to be inferior to the non-tax specification. For the business sector, the two specifications generate almost identical error statistics. These two findings agree with the results obtained from the specification tests.

In the case of aggregate demand for money, however, the RMSE generated by the non-tax specification is approximately 62 percent larger than the one reported by the tax-adjusted formulation. This implies, for the aggregate sector, the net interest money demand equation is clearly superior to the alternative specification, at least based on this experiment.

Identification and Simultaneity

Introduction

A conventional formulation of the money demand function has real money balances related to the interest rate on relevant substitute assets and some measure of economic activity, such as income or wealth. Given the conventional specification, least squares estimation of the demand for money is appropriate if one assumes unidirectional causation from the argument of this demand to the dependent variable, with no direct feedback. However, a close examination of economic theories suggests that one way causation from the arguments of the demand for money to the dependent variable, i.e., M1, may not be warranted and therefore the estimate of the coefficients derived by least squares regression methods would be inconsistent.

In the process of testing the hypotheses, this study used the least squares regression technique to estimate the coefficients. It is important to test if real income and interest rates can be regarded as strictly exogenous in money demand equations.

Exogeneity Test

Sims [74] proposed a statistical test for unidirectional causality. Consider the following regression model:

$$Y_t = BX_t + u_t$$

where X_t represents a matrix of observations on the independent variables. Sims' exogeneity test consists of regressing Y on the past and future values of X. If causality runs from X to Y only, the future values of X have coefficients insignificantly different from zero [74, p. 545].

Put in the context of the demand for money equation, the exogeneity test can be conducted by regressing Ln M1 on the leading and lagged values of the explanatory variables, Ln Y, Ln RCP, and Ln RTD. If the future values of the independent variables have coefficients insignificantly different from zero, as a group, then the null hypothesis that causality runs from the argument of the demand for money to M1 only cannot be rejected.

Sims [74] argues that (1) the length of the estimated lag distribution of independent variables should be determined empirically, and (2) the shape of these lag distributions should not be subject to any prior smoothness restrictions [p. 545]. The second suggestion implies that no lag restrictions are to be imposed a priori.

Given these considerations, a general distributed-lag version of the aggregated demand for money was specified in the following form

$$\text{Ln M1} = \alpha + \sum_{K=-4}^{4} B_i \text{ Ln Y } (t-K) + \sum_{K=-4}^{4} \gamma_i \text{ Ln RCP } (t-K) \quad (1)$$

$$\sum_{K=-4}^{4} \sigma_i \text{ Ln RTD } (t-K)$$

Four leading and four lagged terms were considered, since when estimated empirically, the accumulated-lag weights on income and interest rates did not change significantly after the inclusion of current and four-lagged terms.

In addition to equation (1), Poole [67], Goldfeld [35], and Laidler [54] suggest that the demand for money can be estimated by regressing interest rates on money and income. The exogeneity of the right hand side variables can be tested using Sims' test on the following equation.

$$\text{Ln RCP} = \alpha + \sum_{K=-4}^{4} B_i \text{ Ln Y } (t-K) + \sum_{K=-4}^{4} \gamma_i \text{ Ln M1 } (t-K) \quad (2)$$

$$+ \sum_{K=-4}^{4} \sigma_i \text{ Ln RTD } (t-K)$$

The results of the estimated coefficients on the lag profile for equations (1) and (2) are reported in Table XXVII.

An F-test was conducted to see if the joint coefficients of the leading series of the right hand side variables in equations (1) and (2)

TABLE XXVII

ESTIMATED LAG PROFILE FOR REAL DEMAND FOR MONEY

Coefficients on Lags of	Equation (1) Regression Coefficients on			Equation (1) Regression Coefficients on			Equation (2) Regression Coefficients on			Equation (2) Regression Coefficients on		
	Ln Y	Ln RCP	Ln RTD	Ln Y	Ln RCP	Ln RTD	Ln Y	Ln M1	Ln RTD	Ln Y	Ln M1	Ln RTD
-4	-.097	-.008	.001	-.169	-.006	-.008	-1.12	2.28	-.227	2.76	-.850	.337
-3	.041	.007	-.006	-.0003	.012	-.027	-2.87	.471	-.240	-1.63	-1.21	-.043
-2	.111	-.018	-.041	.112	-.017	-.045	-1.00	3.31	.302	-1.73	3.22	.0576
-1	.186	-.010	-.014	.209	-.0007	-.009	4.96	4.78	.022	5.43	6.95	-.304
0	.292	-.014	-.029	.183	-.019	-.017	2.13	-9.76	-.121	3.27	-2.91	-.296
1	---	---	---	-.041	.019	.007	---	---	---	-2.03	-5.44	.570
2	---	---	---	.047	-.005	-.042	---	---	---	-1.76	.393	-.097
3	---	---	---	.044	.009	.003	---	---	---	-1.63	3.98	.021
4	---	---	---	.095	.003	.025	---	---	---	-.842	-5.54	.024
Sum of the Coefficients	.53	.043	.089									

are significantly different from zero. The results of the F-test are reported in Table XXVIII.

Table XXVIII indicates that, when Ln M1 is regressed on Ln Y, Ln RCP and Ln RTD, the null hypothesis of the right hand side variable's being strictly exogenous cannot be rejected. However, when Ln RCP is used as the dependent variable, the result indicates that, in this specification, the right hand side variables are not strictly exogenous.

TABLE XXVIII

F-TESTS ON FUTURE COEFFICIENTS IN REAL-MONEY DEMAND EQUATIONS

Equation	F-Statistics	F-Table
(1)	1.55	2.00*
(2)	3.57	2.00*

*Degrees of freedom for F-Table are 12 and 48.

The exogeneity test performed on equation (1) implies that the null hypothesis of unidirectional causation from M1 to independent variables cannot be rejected. Therefore, the estimated coefficients of the demand for money derived from the least squares regression model are not inconsistent. However, if Ln RCP is used as the dependent variable, the same conclusion could not have been drawn.

Aggregated Demand for Money and Simultaneity

The results of the exogeneity test imply that there is undirectional causation from the arguments of the demand for money to the dependent variable. However, this conclusion is contrary to the theoretical prediction. The theoretical work suggests that changes in M1 have a short-run inverse effect on the rate of interest. Therefore, this rules out the unidirectional causation from interest rate variables to the supply of money. In light of this apparent dichotomy, it is the intention of this study not to accept the exogeneity test results at face value and to address the issue of simultaneous equations bias.

In order to carry out simultaneous estimation, the aggregated demand for money was reestimated by a two-stage least squares regression model (TSLS). In carrying out the TSLS procedure, income and interest rates were treated as endogenous. The instruments used were population, real state and local government expenditures, discount rate, lagged money stock, gross national product deflators, and the real consumption expenditures. In the process of estimation, it became apparent that the TSLS estimation of the aggregated demand for money should be corrected for serial correlation. To ensure consistency for two-stage least squares estimation when adjusted for serial correlation (TSCORC), four additional instruments--income lagged one quarter, both interest rates lagged one quarter, and money supply lagged two quarters--were included.

Both versions of the aggregated demand for money, non-tax adjusted and tax-adjusted specification, were fitted to the empirical observation of the data by TSCORC procedures. The results are reported in Table XXIX.

TABLE XXIX

EMPIRICAL ESTIMATION OF THE AGGREGATED DEMAND FOR MONEY
BY TSCORC PROCEDURE
1952:2-1972:4

Variables	Estimated Coefficients	
	Non-Tax Specification	Tax-Adjusted Specification
Constant	.385 (1.69)	.497 (1.88)
Ln Y	.176 (4.35)*	.236 (4.99)*
Ln RCP	-.0236 (-5.56)*	-.0242 (-4.70)*
Ln RTD	-.0280 (-2.66)*	-.0413 (-3.19)*
Ln M1(-1)	.719 (8.26)*	.621 (6.33)*
R^2	.9963	.9961
Standard Error of the Regression	.0044	.0044
Durbin-Watson	1.9186	1.9568
Rho	.523	.674
Long-Run Elasticities:		
M1, Y	.63	.62
M1, RCP	.08	.06
M1, RTD	.10	.11

*Significantly different from zero at 5-percent level.

The numbers in parentheses correspond to the t-statistics.

Comparison of Table XXIX and Table VI reveals that the results obtained by ordinary least squares after adjustment for serial correlation and TSCORC are fairly similar to each other. Correcting for both simultaneity and serial correlation yields a slightly lower short-run income elasticity in the case of non-tax specification, but the long-run elasticities are almost the same.

Given the generally comparable estimated coefficients for the two regression models, the results obtained by the exogeneity test are confirmed; and simultaneity bias is not likely to be important.

CHAPTER V

SUMMARY AND CONCLUSION

While income taxation had long ago been integrated into the analysis of most areas of economic behavior, the published empirical work on the topic lacks direct empirical analysis of the response of the demand for money to changes in the tax rate. The possible explanation for this lack of interest may have had to do with the fact that, until recently, a reliable statistical series on the marginal tax rate was not available.

With regard to the availability of marginal tax series, Seater [73] looked across classes of adjusted gross income data and analyzed the relation between taxes paid per return and income per return. In brief, Seater's estimation procedure involved using the ratio of the change in taxes to the change in income to calculate marginal tax rates for each class of income. Alternatively, Barro and Sahasakul [3], following a utility maximization approach, argued that the explicit marginal tax rate from the tax schedule, and not Seater's estimated figures, are the relevant proxies for capturing the underlying substitution effects from taxation. Using the explicit marginal tax rate from the tax schedule, they estimated an average marginal tax rate by adjusted gross income.

The difference between the two estimation techniques is that Seater allowed the concept of deductions--and, therefore, the response of deductions--to enter his estimation procedure, while Barro and Sahasakul exclude this notion from their computation. Consequently, Seater's estimates are lower than Barro and Sahasakul's values. However, in the process of empirical work, this study found the choice between the two is not important for the purpose of empirical investigation. This is, of course, a result of the high correlation between the two series. Both series give approximately the same results when incorporated into the demand for money. Therefore, Seater's estimated series is used to adjust the conventional specification of the demand for money.

This analysis points out that the unavailability of statistical series on marginal tax rates is not a justifiable reason for the apparent lack of interest in investigating the relationship between taxes and the demand for money.

On theoretical grounds, it was argued that the conventional approach toward specifying the demand for money is to use the transactions model. Despite the popularity of this model, one can also use the portfolio approach toward the demand for money and arrive at the same specification, namely, a demand for money as a function of a scale variable and the rate of interest. Using the portfolio approach, Domar-Musgrave [21] and Tobin [81] demonstrated an inverse relationship between changes in the tax rate and the optimal demand for money. The nature of the relationship was argued to be indirect through the effects of taxation on risk taking.

According to Domar-Musgrave and Tobin's work, as the tax rate increases, given that the full loss offset provision is in effect, there would be no incentives to take less risk or the substitution effect of taxation on risk-taking disappears. Interest income, however, declines, and to restore it, investors take more risk by reducing the proportion of their total assets held in cash. Consequently, the risk-sharing effect postulates an inverse relationship between the tax rate and the demand for money.

The inventory approach [4] toward the transactions demand for money predicts a direct and positive relationship between the tax rate and the demand for money. The key element in the transaction model is the interest rate differential between interest bearing assets and money. Based on this model, there is a negative relationship between this interest rate differential and the optimal demand for cash balances. It was argued that the imposition of taxation on interest income reduces the yields on interest bearing assets relative to cash, therefore resulting in larger money balances. The conclusion follows that there is a direct and positive substitution effect that results from changes in the tax rate.

As a result, it was argued that the nature of the relationship between the demand for money and the tax rate remains unclear and therefore an econometric question.

Further, following the inventory approach, it was argued that, for an individual who acts to maximize interest earnings, the true opportunity cost of holding money should be represented by the net rate of interest. Therefore, the concept of income taxation was incorporated into the money demand equation by replacing the nominal rate of interest by this rate net of taxes.

The tax-adjusted money demand specification for the household, business, and aggregated sectors, then provided direct comparison with non-tax specifications for these sectors and three sets of hypotheses were stated. For the household demand for money, the null hypothesis was that the non-tax specification is the true model. The empirical tests led to rejection of the null hypothesis. The tests clearly pointed out that the non-tax specification is superior to the tax-adjusted specification, or it is the nominal and not the net-rate of interest which is the relevant proxy for capturing the opportunity cost of holding money.

This result should not be viewed as totally unexpected given the discussion of the substitution and risk-sharing effects. In the case of the household sector, it is shown that the risk-sharing effect dominates the substitution effect. This finding has two major implications; first, the tax rate indeed belongs in the household demand for money, and second, there is a negative relationship between t and the optimal money balances. It is clear that the latter contradicts the theoretical prediction of net interest demand for money equation. This is most obvious since a net interest money demand function clearly predicts a positive relationship between the money balances and t.

In this context, the question should no longer be whether t is a valid argument in the household demand for money (since apparently it is), but rather, what is the most appropriate way to incorporate t into this function. In other words, should the effects of t be captured by using a net interest money demand equation or should the tax rate be included as a separate independent explanatory variable? It appears that the latter is the appropriate approach. This conclusion is drawn based on the following:

1. The fact that the specification tests reject the notion of net interest demand for money as the true specification.

2. The nature of the relationship between t and household demand for money is found to be negative. This sharply contradicts the theoretical prediction of a net interest demand for money function.

The conclusion for the household is that a household demand for money in terms of the net rate of interest is found to be misspecified. The empirical results seem to suggest that the correct specification for this sector is:

$$M1H = M1H\ (Y,\ r,\ t)$$

with $\frac{\partial M1H}{\partial r} < 0$, $\frac{\partial M1H}{\partial Y} > 0$ and $\frac{\partial M1H}{\partial t} < 0$. M1H is the household real balances, Y denotes the scale variable, r is the nominal rate of interest and t is the marginal tax rate.

Following the inventory approach, it was argued that for the business demand for money the cost of transacting between cash and the alternative forms of holding assets are money costs and, therefore, tax deductible. Consequently, the income tax would reduce both the marginal costs and returns of cash economizing by the same proportion and leave the business demand for money invariant with respect to tax rate. Given this argument, the null hypothesis was that the tax-adjusted formulation of this demand is the true model. The empirical estimates led to rejection of this hypothesis, therefore pointing toward the fact that the two alternative specifications are basically the same and there is nothing to be gained by including the tax rate in the argument of this sector's demand for money.

With respect to the last hypothesis, dealing with aggregated demand for money equation, the specification test indicated that neither specification can be rejected when tested against the alternative formulation. In a sense, the two equations are basically the same. This is, of course, in agreement with expectations given the results of the empirical tests with respect to the substitution and risk-sharing effects. In the case of the aggregate demand for money the results indicate that these two effects cancel each other. This implies that the aggregate money demand equation is invariant with respect to changes in the tax rates, and therefore the two specifications should be the same.

The major conclusion of this study is that conventional empirical specification of the demand for money was not found to be inconsistent and misspecified. Though theory indicates that net rate of interest is the appropriate rate, the empirical results suggest that the empirical benefits from doing so are quite modest.

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APPENDIX

CONSTRUCTING MARGINAL TAX RATE AND DATA SOURCES

Construction of the Average Marginal Tax Rate

The implicit conclusion that can be drawn from Chapter II is that earlier empirical work has misspecified the demand for money equation. The misspecification arises from the fact that earlier papers ignored the role of the income tax structure. First, by representing the opportunity cost of holding money by the nominal rate of interest, thus ignoring the fact that interest receipts are subject to income tax. Second, by ignoring the effect of the tax on optimal bond holding as suggested by Tobin and others.

This misspecification can be corrected by arguing that the opportunity cost of holding money is not the interest rate but this rate net of taxes. However, in order to test statistically this proposition, one should overcome a serious problem--the fact that there are no published statistical series on marginal tax rates. At least three alternative approaches exist to get around this problem. First, the average tax rate can be used as a proxy for the marginal tax rate. Second, an econometric model can be constructed so as to estimate these rates. Third, an estimation technique can be applied to come up with a statistical series on marginal tax rates.

The first two alternatives are ruled out since the average tax rates are not truly appropriate proxies for the marginal tax rates and constructing an econometric model to estimate marginal tax rates is beyond the scope of this research and is a topic for investigation on its own merit. Therefore, this dissertation resorted to the third alternative and used an estimation technique to compute an average marginal tax rate for the economy.

One estimation technique to compute the average marginal tax rate is proposed by Seater [73]. Seater, for the individual income tax, looked across classes of adjusted gross income from the Statistics of Income data and analyzed the relation between taxes paid per return and income per return. Seater's technique is applied and his series on marginal tax rates is revised and updated in the following manner:

1. Define x as the midpoint of an income class.

2. Define $MTR(x) = (ATR(x) - ATR(x_{-1}))/(x - x_{-1})$; where $MTR(x)$ = the marginal tax rate for income class x, $ATR(x)$ = average tax paid for class x (total tax paid by those in income class x divided by the number of returns in class x), and $ATR(x_{-1})$, x_{-1} denotes the average tax paid and the midpoint of an income class for the income class preceding class x.

3. Step two would provide a collection of marginal tax rates, one for each income class. To compute an average marginal rate for the economy, a weighted average of the individual income class rates was computed in the following manner.

$$t_t^i = \sum_{j=1}^{n} \left(\frac{y_{j_t}}{y_t} \cdot MTR(x_{j_t})\right) \tag{1}$$

where t_t^i = average marginal personal income tax rate at time period t,

y_{j_t}/y_t = the fraction of total net income that fell within the jth income class at time period t,

and $MTR(x_{j_t})$ = marginal tax rate for the jth income class at time period t.

The Seater estimation technique involves using the ratio of the change in taxes to the change in income to calculate marginal tax rates for each income class. However, Barro and Sahasakul [3] have argued that the Seater estimate of the marginal tax rate cannot represent the true underlying substitution effects from taxation.

According to Barro and Sahasakul, family income can be represented by:

$$Y = I + wL \tag{2}$$

where L is the amount of work, w is the wage rate and I is the nonlabor income. Taxes, however, depend on taxable income, or,

$$Y^T = Y - D \tag{3}$$

where D is the concept of deductions. Deductions depend on two factors: first, the amount of resources that people devote to generating deductions and, second, the quantity of family consumption that can be considered deductible.

The relation of taxes to taxable income can be captured by

$$T = T(Y^T) \tag{4}$$

where T' is defined as the explicit marginal tax rate from the tax schedule. Seater's approach was an investigation on how taxes vary cross-sectionally with total income, Y. This can be shown by:

$$\frac{dT}{dY} = T' \left(1 - \frac{dD}{dY}\right) \tag{5}$$

It is clear that Seater's estimation of the marginal tax rate, or dT/dY, is below the explicit marginal tax rate, T', because of the positive relation between income and deductions, dD/dY.

However Barro and Sahasakul, following a utility maximization approach, show that the utility rate of substitution between both ordinary consumption and deductible consumption and leisure depends partly on the marginal rate from the tax schedule, t'. Based on these results, they argue that it is the explicit marginal tax rate from the tax schedule, and not dT/dY, which represents the underlying substitution effects from taxation. Using the explicit marginal tax rate from the tax schedule, they estimate an average marginal tax rate by weighting each income class marginal tax rate by adjusted gross income applying both arithmetic and geometric averaging techniques.

As can be seen from Table XXX the comparison of the two estimates of the marginal tax rate indicate that Seater's estimations are below Barro and Sahasakul's values. Despite this, one should suspect that the correlation between the two series would be high. If this proves true, then the choice between the two may be less important for the purpose of time-series analysis. However, Barro and Sahasakul argued that, "There are substantial differences in the behavior of series over time," (p. 483) and therefore one cannot be sure how important these differnces really are in empirical work.

With respect to this, it is the intention of this dissertation to use both series and to investigate the behavior of the demand for money in both cases.

TABLE XXX

AVERAGE INDIVIDUAL MARGINAL TAX RATES
1952-1980

Year	Seater	Barro-Sahasakul
1952	18.1%	26.8%
1953	17.8	26.4
1954	16.1	23.7
1955	16.3	24.4
1956	16.4	24.7
1957	16.4	24.6
1958	16.3	24.3
1959	16.6	25.1
1960	16.4	24.8
1961	17.3	25.4
1962	17.2	25.7
1963	17.4	26.0
1964	14.6	23.0
1965	14.0	22.1
1966	14.6	22.6
1967	14.9	23.2
1968	17.3	26.4
1969	17.9	27.4
1970	17.2	25.4
1971	16.8	24.9
1972	16.7	25.2
1973	17.1	26.0

TABLE XXX (Continued)

Year	Seater	Barro-Sahasakul
1974	17.6	26.8
1975	17.4	27.3
1976	17.9	28.3
1977	17.7	28.3
1978	18.1	31.9
1979	18.0	30.2
1980	18.8	31.8

The marginal corporate tax rate was taken from a different source. This variable was taken from the Wharton Econometric Forecasting Associates, Quarterly Model, Historical Data, selected issues.

Using the marginal personal and corporate income taxes, a weighted average marginal tax rate was calculated in the following manner:

$$t_t = \left(\frac{M_1{}^H}{M_1}\right) \cdot t_t^i + \left(\frac{M_1{}^F}{M_1}\right) \cdot t_t^c \tag{6}$$

Where $M_1{}^H$ and $M_1{}^F$ are the households' and firms' holdings of currency and demand deposits, respectively. M_1 is defined as the total currency and demand deposits in the hands of the nonbank public, t_t^i and t_t^c are the marginal individual and marginal corporate tax rates.

Data Sources

The GNP variable was taken from the National Income and Product Accounts of the United States, (NIPA), Statistical Tables, selected issues. The nominal variables were converted into real terms by the use of the implicit GNP deflator, taken from NIPA. M1 was defined as currency plus demand deposits, and this was taken primarily from the Federal Reserve Bulletin, selected issues. For RCP, the rate on four to six month commercial paper was taken from the Federal Reserve Bulletin. For RTD, the rate on commercial bank passbook deposits was used. The data for this variable was taken from the quarterly econometric FMP model of the Federal Reserve Bank of Kansas City. The M_1^B and M_1^H variable was taken from the Flow of Funds Accounts. The average marginal individual was estimated using John Seater's [73] estimation technique, and Individual Income Tax Returns. The SALE variable was defined as the real manufacturing and trade sales and CONS was defined as real personal consumption expenditures and was taken from Business Conditions Digest. The study uses quarterly observations covering the 1952:2 to 1980:4 time period.

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